Chapter 3
Science and Engineering Workforce

Contents

Highlights

♦ **There were 12.5 million people with science or engineering degrees or who were working as scientists or engineers, residing in the United States as of April 1997—10.6 million in the workforce.** Of these 10.6 million individuals working in the United States in 1997, the vast majority (10.1 million) held at least one university degree in a science or engineering field. About 30 percent (3.1 million) of the 10.1 million S&E degree holders in the workforce were also employed in S&E occupations.

♦ **A little more than half of the 4.9 million S&E degree holders working outside S&E in 1997 were employed in either management-administration occupations (29 percent), sales and marketing jobs (16 percent), or non-S&E–related teaching positions (9 percent) in 1997.** Almost 90 percent of those employed as non-S&E teachers said that their work was at least somewhat related to their S&E degree field, compared to 71 percent of managers-administrators and 47 percent of those employed in sales and marketing jobs.

♦ **Women made up slightly more than one-fifth (23 percent) of the S&E workforce, but close to half (46 percent) of the U.S. labor force in 1997.** Although changes in the NSF surveys do not permit analysis of long-term trends in employment, short-term trends show some increase in the representation of women with doctorates in S&E employment: women represented 23 percent of scientists and engineers with doctorates in the United States in 1997. In 1993, they represented 20 percent and in 1995, 22 percent.

♦ **By age 63, 50 percent of S&E bachelor's and master's degree holders were not working full-time.** For S&E Ph.D. holders, this 50 percent mark is not reached until three years later, at age 66. By age 70, only 10 percent of bachelor's and master's degree holders and 20 percent of Ph.D. holders were working full-time.

♦ **With current retirement patterns, the total number of retirements among S&E degreed workers will dramatically increase over the next 10–15 years.** This will be particularly true for Ph.D. holders because of the steepness of their age profile.

♦ **The private for-profit sector is by far the largest employer of S&E workers**. In 1997, 73 percent of scientists and engineers who had bachelor's degrees and 60 percent of those with master's degrees were employed in a private, for-profit company. The academic sector was the largest sector of employment for those with doctorates (49 percent), but only 32 percent of S&E doctorates were in tenure-track positions at four-year institutions. Sectors employing smaller numbers of S&E workers included educational institutions other than four-year colleges and universities, nonprofit organizations, and state or local government agencies.

♦ **In 1993 only 28.5 percent of college graduates employed in computer occupations had computer science degree.** This rose to 45.2 percent of those in computer occupations who were under age 30.

♦ **In 1997 the median annual salary of employed S&E bachelor's degree holders was $52,000; for master's recipients, it was $59,000 and for doctorate holders $62,000.** Engineers commanded the highest salaries at each degree level. The second highest salaries were earned by computer and mathematical scientists at the bachelor's and master's levels, and physical scientists and computer and mathematical scientists at the doctorate level. The lowest median salaries were reported for social scientists at each degree level.

♦ **Aggregate measures of labor market conditions changed only slightly for recent doctoral recipients in S&E, defined here as those one to three years after their degree.** Unemployment fell from 1.9 percent for a similar graduation cohort in 1995 to 1.5 percent in 1997. At the same time, the proportion of recent Ph.D. recipients reporting that they were either working outside their fields because jobs in their fields were not available, or were involuntarily working part-time, rose slightly from 4.3 percent to 4.5 percent.

♦ **With the exception of young fields, such as computer sciences (where 70 percent of degree holders are under age 40), the greatest population density of individuals with S&E degrees occurs between age 40 and 49.** The aging of the S&E workforce has both positive and negative implications for different aspects of research productivity, and presages a rapid increase in the number of S&E workers of all degree levels reaching traditional retirement ages.

♦ **In April 1997, 26.1 percent of holders of doctorates in S&E in the United States were foreign born.** The lowest percentage of foreign-born doctorates was in psychology (7.2 percent), and the highest was in civil engineering (52.0 percent). Almost one-fifth (19.2 percent of those with master's degree in S&E were foreign born. Even at the bachelor's degree level, 9.7 percent of those with S&E degrees were foreign born—with the greatest proportion in chemistry (15.9 percent), computer sciences (15.6 percent), and across all engineering fields (14.9 percent).

Introduction

In 1947, the Steelman report discussed the science and engineering (S&E) labor force in a chapter entitled “Manpower: The Limiting Resource,” in which it stated that research and development (R&D) activities were limited by “the availability of trained personnel, rather than the amount of money available.” It reported the pool of scientists and “research engineers” in the United States to be 137,000, of whom 25,000 had doctorates. In 1997, the National Science Foundation (NSF) estimated that there were 3.1 million workers in S&E occupations and a total of 10.1 million workers with S&E degrees.[1] In spite of these larger numbers of S&E workers, there is more of a debate today as to whether the size of the S&E workforce is a constraint on new knowledge, innovation, and technological advancement. It should be noted, however, that the vast majority of those with S&E degrees, particularly at the graduate level, are employed in jobs that are relevant to their degrees, and intensive technical knowledge finds uses in many places outside the laboratory.

This chapter first examines the major indicators and characteristics of the S&E labor force. Information on the sex and racial or ethnic composition of the S&E workforce is presented next, followed by a description of the labor market conditions for recent bachelor’s, master’s, and doctoral S&E degree recipients. A discussion of the impact of age and retirement on the S&E labor force is presented next. The chapter also provides data on the projected demand for S&E workers over the 1998–2008 decade. It concludes with a brief section on foreign-born scientists and engineers, and presents comparisons regarding international R&D employment.

Selected Characteristics of the S&E Workforce

The data in this section are from the NSF’s Scientists and Engineers Statistical data system (SESTAT), which is a unified database primarily containing information on the employment, education, and demographic characteristics of individuals with S&E degrees in the United States. (See NSF 1999f.)[2,3]

How Large Is the U.S. S&E Workforce?

Estimates of the size of the U.S. S&E labor force can vary dramatically depending on what criteria are used to define a scientist or engineer. (See the sidebar, “Who Is a Scientist or Engineer?”) Educational degree levels and fields, occupational categories, or a combination of these factors may all be taken into account.[4] In 1997, more than 12.5 million people in the United States either held degrees in science or engineering or were working as scientists or engineers. (See appendix table 3-1.) The number of individuals holding a college degree in an S&E field in 1997 exceeded by a large margin the number of persons working in an S&E occupation because many S&E degree holders were not working in an S&E field. Numerous individuals were also working in S&E occupations who were educated in fields not considered science or engineering related.

Basic Characteristics

Including those either with science or engineering degrees or in science or engineering occupations, approximately 12.5 million scientists and engineers were residing in the United States as of April 1997.[5] Only 84 percent (10.6 million) of these individuals, however, were in the workforce. (See appendix table 3-1.) The remainder were either unemployed, but seeking work (193,700), or were not in the labor force (1.75 million). Of the 10.6 million employed, the vast majority (10.1 million) held at least one college degree in a science or engineering field. About 30 percent (3.1 million) of the 10.1 million S&E degree holders in the workforce were also employed in S&E occupations. (See text table 3-1.)

Relationship Between Education and Occupation

Many of the Nation’s scientists and engineers hold either multiple S&E degrees or have degrees in both S&E and non-S&E fields. Many S&E-educated workers also routinely find S&E-related employment in occupations not included in traditional S&E taxonomies. Of the 10.1 million S&E degree holders in the workforce in 1997, about three-fourths (7.7 million) reported that their highest degree was in an S&E field. (See appendix table 3-2.) Many of these individuals (4.9 million), however, were not principally employed in a traditional science or engineering occupation.

The likelihood of an S&E degree holder occupying an S&E job varies by field of degree. For example, about two-thirds (66 percent) of S&E degree holders whose highest degrees were in engineering fields were employed in an S&E job in

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[1]Although this clearly shows great growth in science and engineering (S&E) education and employment, these numbers probably should not be used to estimate an exact 50-year growth rate. It is not immediately clear how the Steelman estimates were made, and the 1947 number may exclude many classes of workers included in the 1997 NSF estimate.

[2]Selected tables, copies of questionnaires, data quality control information, and the ability to perform simple tabulations from the public use version of SESTAT data are all available from <<http://sestat.nsf.gov>>.

[3]SESTAT data are collected from three component surveys sponsored by NSF and conducted periodically throughout each decade: (a) the National Survey of College Graduates, (b) the National Survey of Recent College Graduates, and (c) the Survey of Doctorate Recipients. SESTAT’s target population is residents of the United States with a bachelor’s degree or higher (in either an S&E or non-S&E field) who, as of the study’s reference period, were:

- Noninstitutionalized,
- Not older than age 75, and
- Either degreed in science or engineering or working as a scientist or engineer—that is, either had at least one bachelor’s or higher degree in an S&E field or had a bachelor’s or higher degree in a non-S&E field and worked in an S&E occupation as of the reference week.

For the 1997 SESTAT, the reference period was the week of April 15, 1997.

[4]For a detailed discussion of the S&E degree fields and occupations in SESTAT, see NSF 1999a.

[5]This number includes all people who have ever received a bachelor’s degree or higher in an S&E field, plus people holding a non-S&E bachelor’s or higher degree who were employed in an S&E occupation during either the 1993, 1995, or 1997 SESTAT surveys.

Who Is a Scientist or Engineer?

There are many different definitions that can be use to classify a scientist or engineer—none of which are perfect. For a more thorough discussion of these complexities, see *SESTAT and NIOEM: Two Federal Databases Provide Complementary Information on the Science and Technology Labor Force* (NSF 1999c) and "Counting the S&E Workforce—It's Not that Easy" (NSF 1999d). Different definitions are used at different places for different analytic purposes in this report, and even more are used in reports elsewhere. These are the three major definitions used in this report:

- **Occupation:** The most common way of counting scientists and engineers in the workforce is to count those with an occupational classification that matches some list of S&E occupations. Although there can be considerable question of how well it is coded from individual write-ins or employer classifications, occupation comes closest to indicating what work a person is actually doing. An engineer by occupation may have a engineering degree, or not, but if classified correctly will be doing engineering work. One limitation of occupation is that it will not capture individuals using S&E knowledge, sometimes extensively, under occupational titles such as manager, salesman, or writer.[*] It is not uncommon for a person with a science or engineering degree in such occupations to report that their work is closely related to their degree, and in many cases also report R&D as a major work activity.

[*] In most collections of occupation data (SESTAT data mostly does not have this problem), the generic classification of post-secondary teacher also masks many university professors who should be included in most concepts of the S&E workforce.

- **Highest degree:** This is another way to classify scientists and engineers if you want to count or describe the characteristics of individuals in the labor force with formal S&E training. Focusing on the field of highest (or most recent) degree often best characterizes the training an individual is utilizing in the labor force (rather than occupation, as discussed above). For example, it may be more appropriate to classify a person with a bachelor's degree in chemistry who is employed as a technical writer for a professional chemists society magazine as a chemist. Using highest degree does not solve all problems, however. For example, should a person with a bachelor's degree in biology and a master's degree in engineering be included among biologists or engineers? Also, should individuals with a bachelor's degree in political science be counted as social scientists if they also have a law degree? Many might be comfortable classifying by highest degree in the examples above, but less comfortable excluding from an S&E labor force analysis an individual with a bachelor's degree in engineering who also has a master's degree in business administration.

- **Anyone with an S&E degree or occupation:** Another approach is to use both occupation and education. NSF's sample surveys of individual scientists and engineers attempt to include those resident in the United States with any science or engineering degree, or with a science or engineering occupation.[†]

[†] Those without U.S. S&E degrees are included in 1997 SESTAT data to the extent they were in the United States in 1990, 1993, 1995, and 1997 (in the case of individuals with foreign S&E degrees) or had at least a bachelor's degree in some field and were working in a S&E occupation in 1993, 1995, and 1997.

1997. However, most of the S&E degree holders who received their highest degrees in life science or social science fields (73 percent and 86 percent, respectively) were working in occupations outside the traditional S&E taxonomy, that is, "non-S&E occupations." (See appendix table 3-2.) About half of those with highest degrees in computer and mathematical sciences and physical sciences (51 percent and 46 percent, respectively) were also employed in a non-S&E occupation in 1997.

The fact that most S&E degree holders do not work in a strictly defined science or engineering occupation does not mean that they are not using their S&E training. Of the 4.9 million S&E degree holders working in non-S&E jobs in 1997, about 65 percent indicated they were working in jobs at least somewhat related to their highest S&E degree field. (See text table 3-2.)[6] Over three-fourths of those with highest degrees in computer and mathematical sciences who were employed in non-S&E jobs were doing work related to their degrees, compared to 61 percent of those whose highest degrees were in social and physical sciences.

[6]Refers to highest degree received.

Out of all employed individuals whose highest degree was in S&E, 74.8 percent said that their jobs were related to the field of their highest degree, and 44.8 percent said their jobs were closely related to their field.[7] This can be seen in appendix tables 3-3 and 3-4. The relatedness of a field of study to an individual's job differs in mostly predictable ways across level of degree, years since degree, and field of degree.

Figure 3-1 shows the percentage of employed S&E degree holders who say their jobs are closely related to their degrees by degree level and years since degree. For the period of one to five years after receiving their degree, 74.1 percent of S&E doctorates say their jobs are closely related to their field of

[7]Although this is a highly subjective self-assessment by survey respondents, it may often capture associations between training and scientific expertise not evident through occupational taxonomies. For example, an individual with an engineering degree, but with an occupation title of "salesman," may still be heavily involved in using or developing technology.

Text table 3–1.
Employed scientists and engineers, by S&E employment status and field of highest degree: 1997

	S&E Employment Status		
	Total	In S&E	In non-S&E
Total employed	10,585,600	3,369,400	7,216,200
Total with no S&E degree	528,000	294,600	233,400[a]
Total with S&E degree	10,057,600	3,074,800	6,982,800
S&E is highest degree	7,704,000	2,840,800	4,863,200
Computer & mathematical sciences	1,003,300	494,800	508,500
Life and related sciences	1,204,700	326,200	878,500
Physical and related sciences	619,200	334,100	285,100
Social and related sciences	2,967,600	421,300	2,546,300
Engineering	1,909,200	1,264,400	644,800
Non-S&E is highest degree	2,353,600	234,000	2,119,600

[a]These individuals were employed in an S&E occupation in a previous job.

NOTE: Details may not add to totals because of rounding.

SOURCE: National Science Foundation, Division of Science Resources Studies (NSF/SRS), SESTAT Surveys, 1997.

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Text table 3–2.
Persons with S&E degrees employed in non-S&E occupations, by highest degree and relationship of degree to job: 1997

	Total[a]	Bachelor's	Master's	Doctorate
All non-S&E occupations	4,863,200	3,994,800	715,300	149,700
	Percent			
Total	100.0	100.0	100.0	100.0
Closely related	32.4	29.2	46.9	48.4
Somewhat related	32.3	32.4	31.5	33.7
Not related	35.3	38.5	21.6	18.0

[a] Includes professional degrees.

SOURCE: National Science Foundation, Division of Science Resources Studies (NSF/SRS), SESTAT surveys, 1997.

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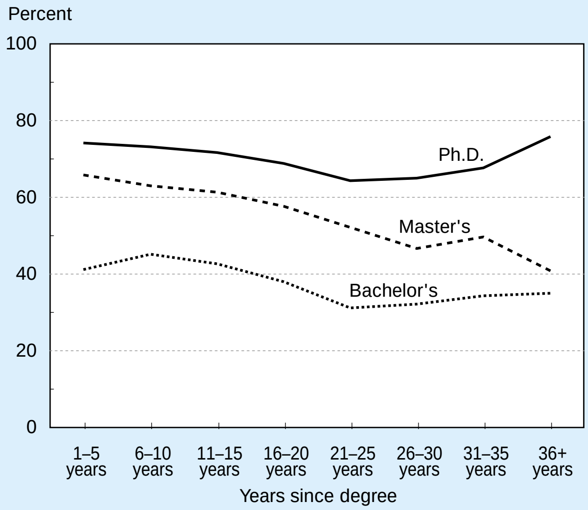
degree, compared to 65.9 percent of those with master's degrees and 41.1 percent of those with bachelor's degrees. This relative ordering of relatedness by level of degree holds across all years since receipt of degree. At every degree level, however, jobs generally become less closely related to field of degree as year since degree increases.[8] There may be many reasons for this—individuals change their career interests over time, they may gain skills in a different area while on the job, they may move into management responsibilities, or some of their original college training may become obsolete. Given all of these possibilities, the career cycle decline in the relevance of an S&E degree is fairly modest.

Differences in proportion for those who said their jobs were closely related to their field of degree are shown in Figure 3-2 for bachelor's degree holders by major groups of S&E disciplines. At one to five years after receipt of degree, the percentage of S&E bachelor's degree holders who said their jobs were closely related to field of degree ranged from 29 percent in the social sciences to 72 percent in computer science. Between the extremes of social sciences and computer sciences, most other S&E fields have similar percentages of recent graduates in closely related jobs—53 percent for physical sciences, mathematical sciences, and engineering, and 45 percent for the life sciences.

[8]One exception to this is for Ph.D. holders more than 25 years after degree, for whom the percent in closely related jobs increases. This may reflect differences in retirement rates.

Figure 3-1.
Percentage of S&E degree holders in jobs “closely related” to their degrees

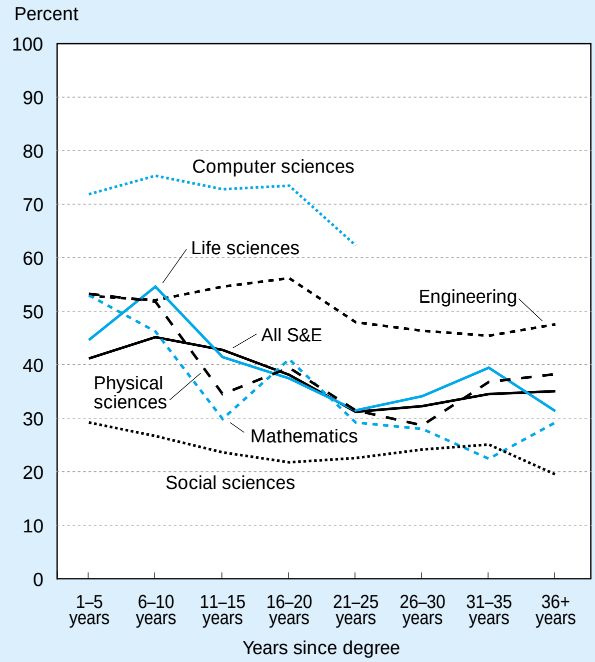


See appendix table 3-3. *Science & Engineering Indicators – 2000*

Employment in Non-S&E Occupations

A little over half of the 4.9 million S&E degree holders working outside S&E occupations in 1997 were employed in either management-administration occupations (29 percent), sales and marketing jobs (16 percent) or non-S&E related teaching positions (9 percent) in 1997. (See text table 3-3.) Almost 90 percent of those employed as non-S&E teachers said that their work was at least somewhat related to their S&E degree field, compared to 71 percent of managers-administrators and 47 percent of those employed in sales and marketing jobs.

Figure 3-2.
S&E bachelor’s degree holders in jobs “closely related” to their degrees



See appendix table 3-3. *Science & Engineering Indicators – 2000*

About 82 percent of the 4.9 million S&E degree holders not working in S&E occupations in 1997 reported their highest degree as a bachelor’s degree, while 15 percent listed a

Text table 3–3.
Persons with S&E as highest degree employed in non-S&E occupations, by occupation and relationship of degree to job: 1997

Occupation	Total	Percent: Total	Relationship of highest degree to job: Closely related	Somewhat related	Not related
Total non-S&E occupations	4,863,200	100.0	32.4	32.3	35.3
Managers and administrators	1,405,000	100.0	29.7	41.4	28.8
Health and related occupations	294,800	100.0	61.0	23.4	15.6
Non-S&E teachers	454,300	100.0	66.9	20.4	12.6
Non-S&E postsecondary teachers	48,700	100.0	68.4	21.7	9.9
Social services occupations	270,800	100.0	60.1	29.1	10.8
Technologists and technicians	309,800	100.0	44.9	33.6	21.5
Sales and marketing occupations	757,500	100.0	10.2	36.8	53.0
Art and humanities occupations	114,800	100.0	19.2	36.8	43.9
Other non-S&E occupations	1,207,500	100.0	19.8	25.7	54.4

NOTE: Details may not add to totals because of rounding.

SOURCE: National Science Foundation, Division of Science Resources Studies (NSF/SRS), SESTAT surveys, 1997.

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master's degree and 3 percent a doctorate. Approximately three-fifths of bachelor's degree holders reported that their jobs were closely related to their highest degree field, compared to four-fifths of both doctorate and master's S&E degree recipients.

Employment in S&E Occupations

Of the 7.7 million scientists and engineers in the workforce in 1997 whose highest degrees were in an S&E field, a little more than a third (2.84 million) were principally employed in S&E jobs. Additionally, there were 234,000 individuals with S&E degrees whose highest degrees were in a non-S&E field who were also employed in S&E occupations. There were also 294,600 college-educated individuals employed in S&E occupations that held no degrees in an S&E field.

Altogether, approximately 3.4 million individuals were employed in an S&E occupation in 1997. (See appendix table 3-5.) Engineers represented 41 percent (1.37 million) of the S&E positions, followed by computer and mathematical scientists with 31 percent (1.04 million) of the total. Physical scientists accounted for less than 10 percent of those working in S&E occupations in 1997. By subfield, electrical engineers made up about one-fourth (365,000) of all those employed as engineers, while biological scientists accounted for a little over one-half (182,000) of the employment in the life sciences. In the physical and social science occupations, chemists (120,000) and psychologists (182,000) were the largest occupational subfields, respectively.

Almost 57 percent of the individuals employed in S&E jobs reported their highest degree type as a bachelor's degree, while 29 percent listed a master's degree and 14 percent a doctorate. Other first professional degrees were reported as the highest degree type by about 1 percent. Almost half of those with bachelor's degrees were employed as engineers. (See text table 3-4.) Another 35 percent of bachelor's degree holders had jobs as computer and mathematical scientists. These occupations were also the most prevalent among those with master's degrees (39 percent and 31 percent, respectively). Most doctorate holders were employed as social scientists (27 percent), life scientists (25 percent) and physical scientists (18 percent). (See the sidebar, "How Important Is Temporary Work for Scientists and Engineers?") (See also the sidebar, "Data on Recent Ph.D. Recipients in Professional Society Data.")

Unemployment

Of the approximately 3.5 million scientists and engineers in the labor force in 1997, only 1.5 percent (52,900) were unemployed. (See figure 3-4.)[9] This compares with 4.9 percent for the U.S. labor force as a whole in 1997 and 2.0 percent for all professional specialty workers. The highest unemployment rates were for life scientists (2.2 percent) and the lowest for social scientists (1.0 percent). By degree level, 1.6 percent of the scientists and engineers whose highest degree was a bachelor's degree were unemployed, compared to 1.4 percent of those with master's degrees or a doctorate. It should be remembered, however, that the unemployment rate is a poor indicator of labor market conditions for highly educated workers—it does not measure how well their employment uses their training.

Sector of Employment

The private for-profit sector is by far the largest employer of S&E workers. In 1997, 73 percent of scientists and engineers with bachelor's degrees and 60 percent of those with master's degrees were employed in a private, for-profit company. (See appendix table 3-6.) The academic sector was the largest sector of employment for those with doctorates (49 percent). Sectors employing smaller numbers of S&E workers include educational institutions other than four-year colleges and universities, nonprofit organizations, and state or local government agencies.

[9]The unemployment rate is the ratio of those who are unemployed and seeking employment to the total labor force (that is, those who are employed plus those who are unemployed and seeking employment). Those who are not in the labor force (that is, those who are unemployed and not seeking employment) are excluded from the denominator. For unemployed individuals, occupation is for their last reported job.

Text table 3–4.
Percentage distribution of employed scientists and engineers by broad occupation and highest degree: 1997
(Percent)

	Total[a]	Bachelor's	Master's	Doctorate
All S&E occupations	100.0	100.0	100.0	100.0
Computer and math scientists	30.8	35.2	31.2	13.0
Life and related scientists	9.5	6.5	7.3	24.6
Physical and related scientists	8.5	6.9	7.1	18.4
Social and related scientists	10.4	3.5	15.6	26.6
Engineers	40.8	47.8	38.8	17.5

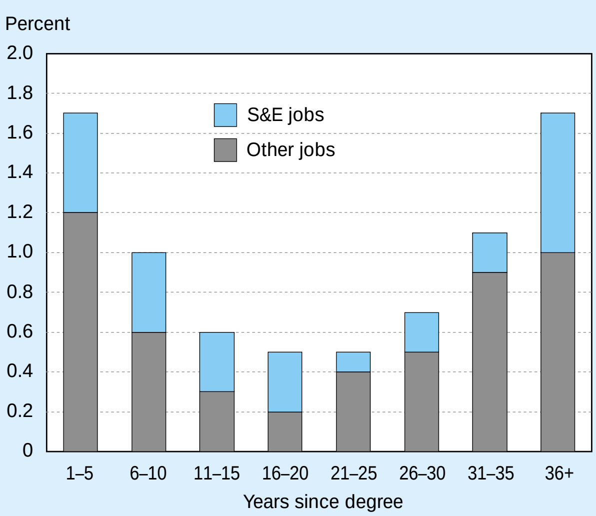
[a] Includes professional degrees.

See appendix table 3–6. *Science and Engineering Indicators – 2000*

How Important Is Temporary Work for Scientists and Engineers?

One common form of flexible work arrangement in the general labor force is the temporary help firm. Although best known as a way for businesses to hire temporary clerical help, major temporary help firms have long included scientists, engineers, and technicians among the workers whom they offer to other businesses on a temporary basis. How important is temporary work as a source of employment for those with S&E degrees? The answer appears to be "not very" for most S&E degree holders. Figure 3-3 shows the percentage of S&E degree holders who in 1997 reported being employed by a temporary help or employment agency. The greatest use of temporary firms occurs for those within just one to five years since receipt of their degrees (1.7 percent) and for those with more than 35 years since receipt of their degrees (1.6 percent). Only about one-third of those with temporary agency jobs are employed in S&E occupations. Ph.D. recipients are less likely than those with other S&E degrees to work for a temporary agency—only 0.4 percent even within one to five years since receipt of degree.

Figure 3-3.
S&E degree holders working through a temporary help or employment agency: 1997



See appendix table 3-20. *Science & Engineering Indicators – 2000*

Among S&E occupations, there was a wide variation in the proportions of scientists and engineers employed in private for-profit industry. While nearly three-fourths of both computer and mathematical scientists and engineers were employed in this sector, only one-fourth of life scientists and one-fifth of social scientists were so employed in 1997. Educational institutions employed the largest proportion of life scientists (48 percent) and social scientists (45 percent).

Salaries

In 1997 the median annual salary of bachelor's degree holders employed in S&E occupations was $52,000; for master's recipients it was $59,000 and for doctorate holders $62,000. (See figure 3-5 and appendix table 3-7.) Engineers commanded the highest salaries at each degree level. The second highest salaries were earned by computer and mathematical scientists at the bachelor's and master's levels, and physical scientists and computer and mathematical scientists at the doctorate level. The lowest median salaries were reported for social scientists at each degree level.

Median salaries for scientists and engineers were higher for those with more years since completion of their highest degree. For example, individuals who earned their bachelor's or master's degrees five to nine years ago earned about $12,000 and $8,000 less, respectively, in 1997 than those who received these degrees 15–19 years ago. For doctorate holders, the difference between the two groups in terms of years since receipt of degree was $14,000. (See appendix table 3-8.)

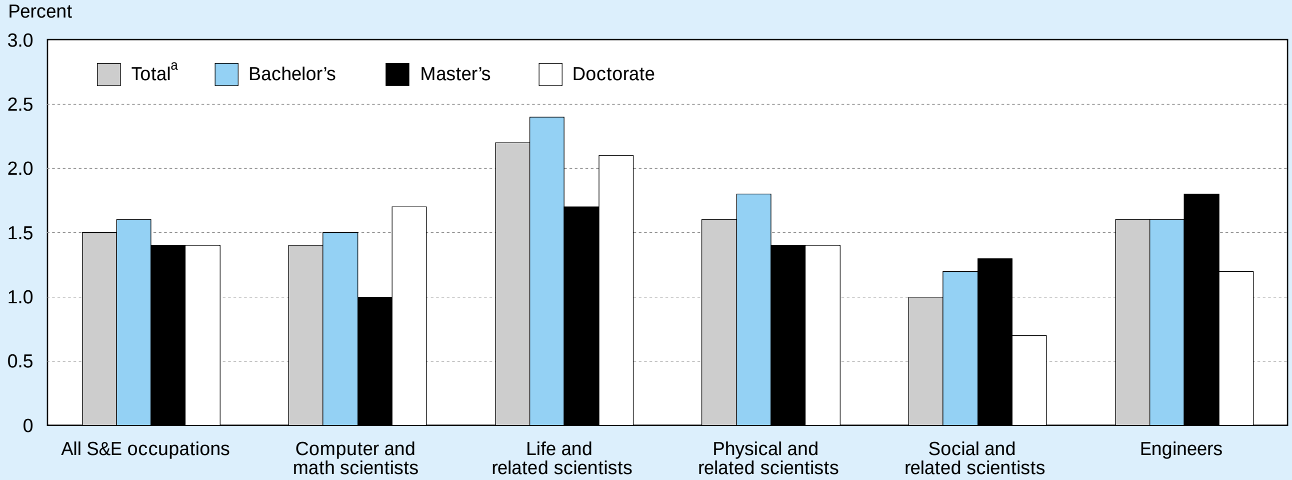
Who Performs R&D?

Although individuals with an S&E education can use that knowledge in a great many other ways—for example, teaching, writing, evaluating, and testing—there is a special interest in those engaged in research and development (R&D). Figure 3-6 shows the distribution of individuals with S&E degrees who reported R&D as a major work activity by level of degree.[10] Those with doctorates comprise only 5.6 percent of all with S&E degrees, but 13.0 percent of those reporting major R&D activities. Despite this, a majority of the S&E degree holders that report major R&D activities have only bachelor's degrees (55.5 percent). Another 28.5 percent have master's degrees, and 2.9 percent have professional degrees (mostly in medicine). Figure 3-7 shows the distribution of individuals with S&E degrees who reported R&D as a major work activity by field of highest degree. Those whose highest degree is in engineering constitute more than one-third (34.9 percent) of those reporting major R&D work activities. Notably, 13.0 percent do not have their highest degree in an S&E field. In most cases, this is a person with an S&E bachelor's degree and a higher degree in a professional field, such as business, medicine, or law.

The involvement of S&E Ph.D. recipients in R&D as a major work activity is shown by field of degree and years since receipt of Ph.D. in figure 3-8. The highest R&D rates over the career cycle are found in the physical S&E. The lowest R&D rates are in the social sciences. While the percentage of employed Ph.D. recipients with R&D as a major work activity does decline with years since degree, it remains above 50 percent in most fields. A steeper decline might have been

[10]Counts of full-time equivalent R&D workers in the United States are based largely on NSF/SRS surveys of employers, rather than the self-reported R&D activity reported in SESTAT that is used here. The comparative advantage of the SESTAT data is the ability to know the characteristics of the individuals involved. Major work activity is defined here as an activity on which an individuals reports spending the most, or the second most, total hours.

Figure 3-4.
Unemployment rates of scientists and engineers by broad occupation and highest degree: 1997



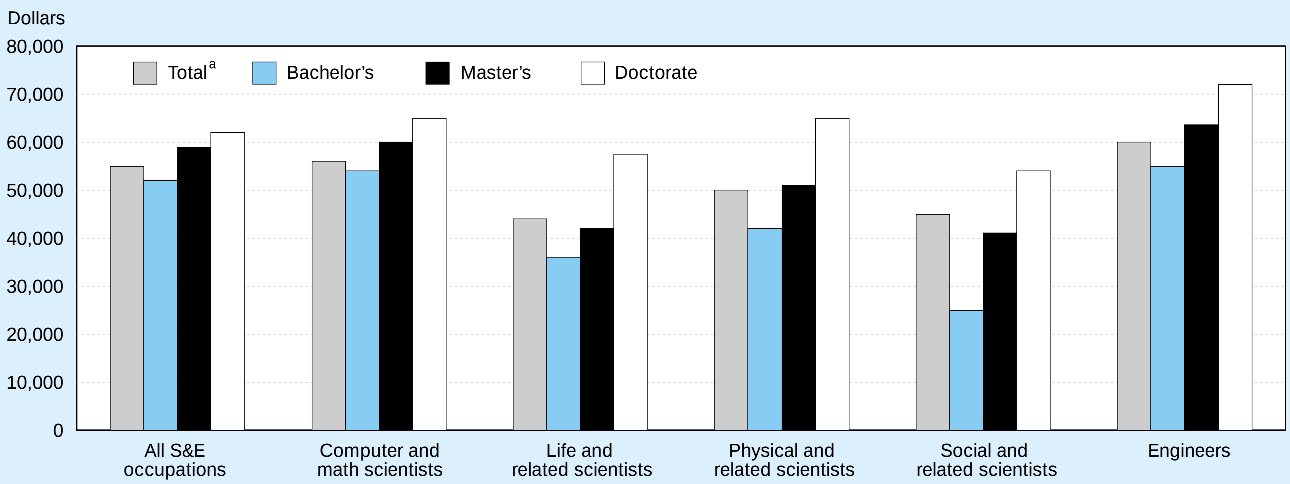
See appendix table 3-5.

NOTE: Individuals are characterized as scientists or engineers based on their current occupation of employed, or on their last reported occupation if unemployed. These figures do not reflect those S&E degree holders employed in non S&E occupations.

[a] Includes professional degrees.

Science & Engineering Indicators – 2000

Figure 3-5.
Median annual salaries of employed scientists and engineers by broad occupation and highest degree: 1997



See appendix table 3-8.

NOTE: Individuals are characterized as scientists or engineers based on their current occupation.

[a] Includes professional degrees.

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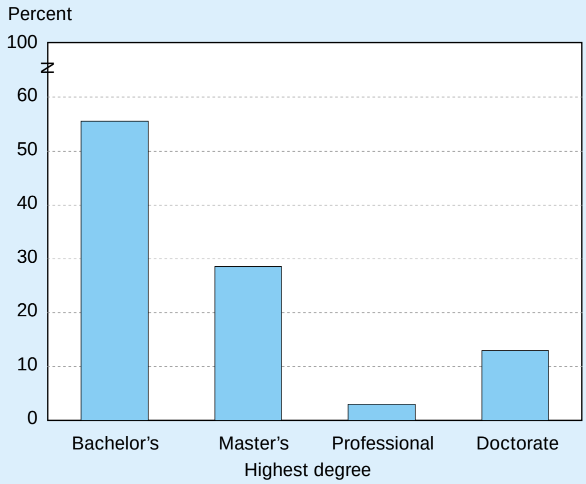
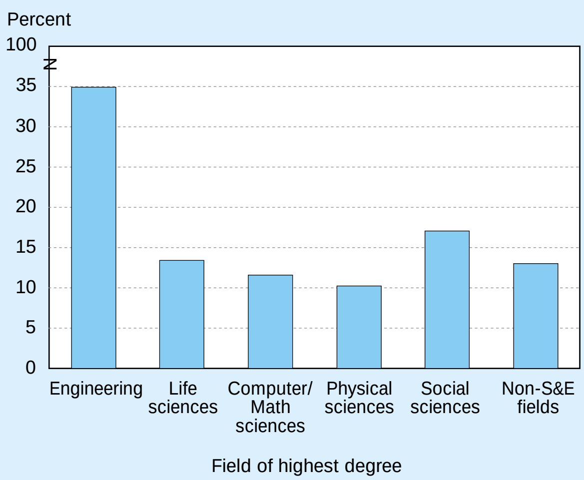
Figure 3-6.
Distribution of S&E R&D workers by degree level



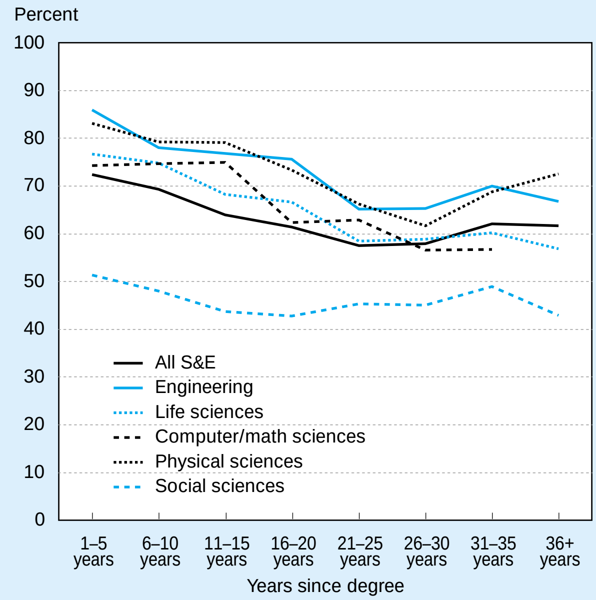
See appendix table 3-26. *Science & Engineering Indicators – 2000*

Figure 3-7.
Distribution of S&E R&D workers by field of highest degree



See appendix table 3-26. *Science & Engineering Indicators – 2000*

Figure 3-8.
Percentage of S&E Ph.D. holders engaged in R&D as a major work activity



See appendix table 3-27. *Science & Engineering Indicators – 2000*

expected, which may reflect a normal career process of movement into management or into other career interests.

Women and Minorities in S&E

This section examines the participation and employment characteristics of women and minorities in the S&E labor force in 1997. Representation is examined, in most cases, in terms of age, time in workforce, field of employment, and highest degree level.[11] These factors influence employment patterns. To the extent that men and women, minorities, and nonminorities differ on these factors, their employment patterns are likely to differ as well.

Within the S&E labor force, the age distributions of women compared to men, and of minorities compared to the majority, are quite different. Because large numbers of women and minorities have entered S&E fields only relatively recently, women and minority men are generally younger and have fewer years of experience. (See appendix table 3-9.) Age or stage in career is an influence on such employment-related factors as salary, rank, tenure, and work activity. Employment patterns also vary by field, and these field differences may influence employment in S&E jobs, unemployment, salaries, and work activities. Highest degree earned is also an important influence on employment, particularly on primary work activity and salary.

Women Scientists and Engineers

Representation in S&E

Women were slightly more than one-fifth (23 percent) of the S&E workforce, but close to half (46 percent) of the U.S. labor force in 1997. Although changes in the NSF surveys do not permit analysis of long-term trends in employment, short-term trends show some increase in the representation of women with doctorates in S&E employment: women represented 23 percent of scientists and engineers with doctorates in the United States in 1997. (See appendix table 3-10.) In 1993, they represented 20 percent and in 1995 22 percent.[12]

[11]Throughout this section, scientists and engineers are defined in terms of field of employment, not degree field.

Work Experience

Many of the differences in employment characteristics between men and women are partially due to differences in time since receipt of degree. Women in the S&E workforce are younger, on average, than men: 49 percent of women and 35 percent of men employed as scientists and engineers in 1997 had received their degrees within the previous 10 years.

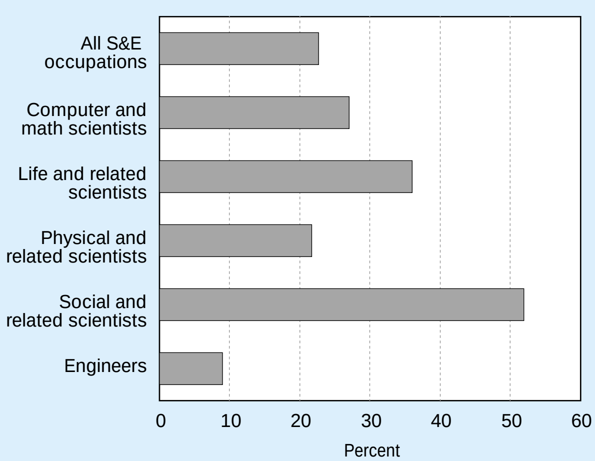
Field of S&E Occupation

As is the case in degree fields, women and men differ in field of employment. Women are more highly represented in some S&E fields than in others. For example, women were more than half of social scientists, but only 22 percent of physical scientists and 9 percent of engineers. (See figure 3-9.) Within engineering, women are also more highly represented in some fields than in others, For example, women represented 12 percent of chemical and industrial engineers, but only 6 percent of aerospace, electrical, and mechanical engineers.

Educational Background

In many occupational fields, women scientists have attained a lower level of education than men. In the science workforce as a whole, 16 percent of women and 20 percent of men hold doctoral degrees. In biology, 26 percent of women and 42 percent of men hold doctoral degrees; in chemistry, 14 percent of women and 28 percent of men hold doctoral degrees; and in psychology, 24 percent of women and 40 percent of men hold doctoral degrees. Differences in highest degree influence the type of work performed, employment in S&E jobs, and salaries. In engineering, only about 5 percent of both men and women have doctoral degrees. (See NSF 1999b.)

Figure 3-9.
Proportion of women in S&E workforce by broad occupation: 1997



See appendix table 3-10. *Science & Engineering Indicators – 2000*

Labor Force Participation, Employment, and Unemployment

Men scientists and engineers are more likely than women to be employed full-time and to be employed in their field of highest degree. Women are more likely than men to be employed part time, and to be employed outside their field. Some of these differences may reflect differences in the age distributions of men and women or family-related reasons, such as the demands of a spouse's job or the presence of children.

The labor force participation rates of men and women with current or former S&E occupations are similar—87 percent of women and 88 percent of men are in the labor force. (See appendix table 3-11.) Conversely, 13 percent of women and 12 percent of men are not in the labor force—that is, not working and not seeking employment. Among those in the labor force, moreover, unemployment rates of men and women scientists and engineers varied somewhat: 2.2 percent of women and 1.4 percent of men were unemployed in 1997.

Sectors of Employment

Within fields, women are about as likely as men to choose industrial employment. For example, among physical scientists, 54 percent of women and 55 percent of men are employed in business or industry. (See appendix table 3-12.) Among employed scientists and engineers as a whole, however, women are less likely than men to be employed in business or industry and are more likely to be employed in educational institutions: 49 percent of women and 67 percent of men are employed in for-profit business or industry and 27 percent of women and 15 percent of men are employed in educational institutions. These differences in sector, however, are mostly related to differences in field of degree. Women are less likely than men to be engineers or physical scientists, who tend to be employed in business or industry.

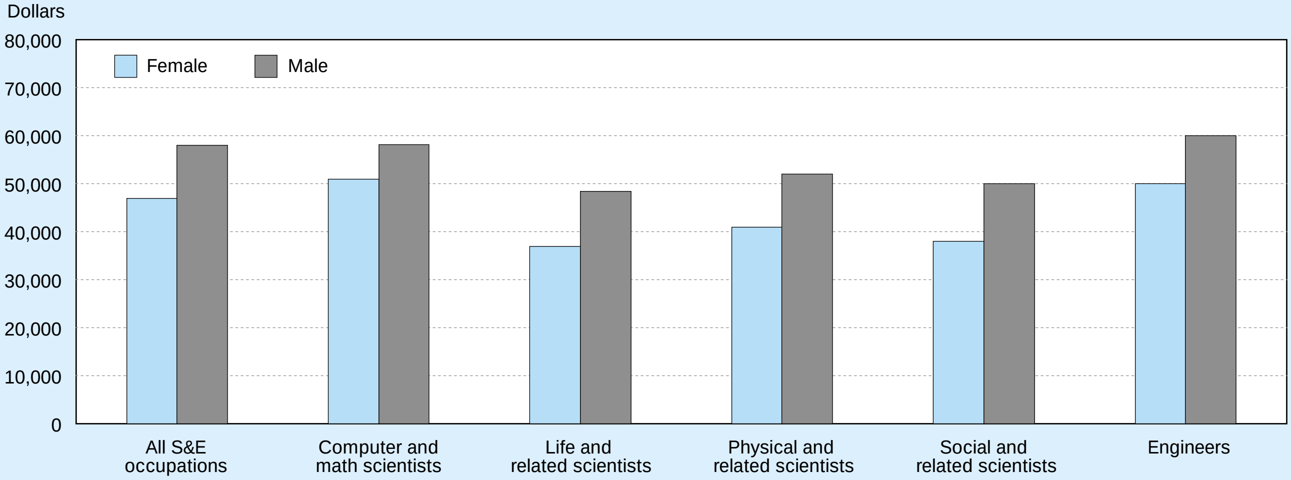
Salaries

In 1997, the median annual salary for women scientists and engineers was $47,000, about 20 percent less than the median salary for men ($58,000). (See figure 3-10 and appendix table 3-8). The salary differential could be due in part to several factors. Women were more likely than men to be working in educational institutions and in social science occupations, in nonmanagerial positions, and to have fewer years since receipt of degree, all of which are related to salary differences. Among scientists and engineers in the workforce who have held their degrees five years or less, the median annual salary of S&E women was 83 percent of that for men.

The salary differential varied greatly by broad field. In computer and mathematical science occupations in 1997, women's salaries were approximately 12 percent less than men's, whereas there was a 24 percent salary difference in social science and life science occupations. As with men,

[12]For 1995 figures, see *Women, Minorities, and Persons with Disabilities in Science and Engineering: 1998* (NSF 1996, p. 99). For 1993 figures, *see Women, Minorities, and Persons with Disabilities in Science and Engineering: 1996* (NSF 1999b, p. 63).

Figure 3-10.
Median annual salaries of employed scientists and engineers, by broad occupation and sex: 1997



NOTE: Individuals are characterized as scientists or engineers based on their current occupation.

See appendix table 3-8.

Science & Engineering Indicators – 2000

women earned the highest median salary in computer and mathematical sciences ($51,000) and the lowest in life sciences ($37,000).

Racial or Ethnic Minority Scientists and Engineers

Representation in S&E

With the exception of Asians, minorities are a much smaller proportion of scientists and engineers in the United States than they are in the total U.S. population.[13,14] Asians comprised 10 percent of scientists and engineers in the United States in 1997, although they were 4 percent of the U.S. population. Blacks (12 percent), Hispanics (11 percent), and American Indians (1 percent) as a group were 24 percent of the U.S. population and 7 percent of the total S&E labor force in 1997.[15] Blacks and Hispanics each comprised about 3 percent and Native Americans less than half of 1 percent of scientists and engineers. (See appendix table 3-13.)

Work Experience

The work experience of minority scientists and engineers, including Asians, differs from that of white scientists and engineers. As noted earlier, these differences influence differences in employment characteristics. About 36 percent of white scientists and engineers employed in 1997 had received their degrees within the previous 10 years, compared with between 47 and 52 percent of Asian, black, and Hispanic scientists and engineers. (See appendix table 3-14.)

Field of S&E

Black, Asian, and American Indian scientists and engineers are concentrated in different fields than white and Hispanic scientists and engineers. Asians are less represented in social sciences than they are in other fields. They represented 4 percent of social scientists, but more than 10 percent of engineers and computer scientists. Black scientists and engineers work more in social sciences and in computer and mathematical sciences than in other S&E fields. They represent 5 percent of social scientists, 4 percent of computer and mathematical scientists, and roughly 3 percent or less of physical scientists, life scientists, and engineers. Although the numbers are small, American Indians appear to be more concentrated in the social sciences. They represent 0.6 percent of social scientists and 0.4 percent or less of workers in other fields. Hispanics represent roughly 2.5 to 4 percent of scientists and engineers in each field.

[13]The term “minority” includes all groups other than white; “underrepresented minorities” include three groups whose representation in S&E is less than their representation in the population: blacks, Hispanics, and American Indian/Alaska Natives. In accordance with Office of Management and Budget guidelines, the racial or ethnic groups described in this section will be identified as white and non-Hispanic; black and non-Hispanic; Hispanic; Asian or Pacific Islander; and American Indian/Alaskan Native. In text and figure references, these groups will be referred to as white, black, Hispanic, Asian, and American Indian.

[14]The data reported in this section include all in S&E occupations, regardless of citizenship or country of origin, unless otherwise noted.

[15]The S&E fields in which blacks, Hispanics, and American Indians earn their degrees influence participation in the S&E labor force. Blacks, Hispanics, and American Indians are disproportionately likely to earn degrees in the social sciences (included by NSF as degrees in S&E) and to be employed in social services occupations, such as social work, clinical psychology, that are defined by NSF as non-S&E occupations. See NSF 1999a for NSF’s classification of S&E educational and occupational fields.

Educational Background

The educational attainment of scientists and engineers differs among racial or ethnic groups. Black scientists and engineers, on average, have a lower level of education than scientists and engineers of other racial or ethnic groups. Black scientists and engineers are more likely than white, Hispanic, or Asian scientists and engineers to have a bachelor's degree as the terminal degree: 64 percent of black scientists and engineers in the U.S. workforce have a bachelor's degree as the highest degree compared to 57 percent of all scientists and engineers in 1997. (See appendix table 3-10.)

Labor Force Participation, Employment, and Unemployment

Labor force participation rates vary by race or ethnicity. Minority scientists and engineers were more likely than whites to be in the labor force, that is, employed or looking for employment. Between 91 and 95 percent of black, Asian, Hispanic, and American Indian scientists and engineers were in the labor force in 1997, compared with 87 percent of white scientists and engineers. (See appendix table 3-13.) Age differences are part of the explanation. White scientists and engineers are older, on average, than scientists and engineers of other racial or ethnic groups: 25 percent of white scientists and engineers were age 50 or older in 1997, compared with between 15 and 18 percent of Asians, blacks, and Hispanics. Among those in similar age groups, the labor force participation rates of white and minority scientists and engineers are similar. (See NSF 1999b.)

Although minorities, for the most part, are less likely to be out of the labor force, among those who are in the labor force, minorities are more likely to be unemployed. In 1997, the unemployment rate of white scientists and engineers was significantly lower than that of other racial or ethnic groups. The unemployment rate for whites was 1.4 percent, compared with 2.6 percent for Hispanics, 1.9 percent for blacks, and 2.0 percent for Asians. The differences in unemployment rates were evident within fields of S&E, as well as for S&E as a whole. For example, the unemployment rate for white engineers was 1.6 percent; for black and Asian engineers, it was 2.5 percent and 2.1 percent, respectively.

Sectors of Employment

Racial or ethnic groups differ in employment sector, partly because of differences in field of employment. Among employed scientists and engineers in 1997, 57 percent of black, 58 percent of Hispanic, and 50 percent of American Indian, compared with 63 percent of white and 67 percent of Asian scientists and engineers were employed in for-profit business or industry. Blacks and American Indians are concentrated in the social sciences, which are less likely to offer employment in business or industry, and are underrepresented in engineering, which is more likely to offer employment in business or industry. Asians, on the other hand, are overrepresented in engineering and thus are more likely to be employed by private for-profit employers.

Black, Hispanic, and American Indian scientists and engineers are also more likely than other groups to be employed in government (Federal, state, or local): 22 percent of black, 16 percent of Hispanic, and 19 percent of American Indian scientists and engineers were employed in government in 1997, compared with 13 percent of white and 12 percent of Asian scientists and engineers.

Salaries

Salaries for scientists and engineers vary somewhat among racial or ethnic groups. Among all scientists and engineers, the median salaries by racial or ethnic group are $55,000 for whites and Asians, $48,000 for blacks, $50,000 for Hispanics, and $46,000 for American Indians. (See figure 3-11 and appendix table 3-16.) Within fields and age categories, median salaries of scientists and engineers by race or ethnicity are not dramatically different and do not follow a consistent pattern. For example, the median salary of engineers with bachelor's degrees who are between the ages of 20 and 29 ranged from $40,000 for Hispanics to $44,000 for Asians. Among those between the ages of 40 and 49, the median salary ranged from $55,000 for Hispanics to $62,600 for whites. Looking at time in the work force, the median salary of engineers with bachelor's degrees in 1997 who had received their degree within the last five years was $40,000 for all ethnicities. (See appendix table 3-17.) Among those who had received their degrees 20–24 years before, the median salary was approximately $65,000 for all ethnicities.

Labor Market Conditions for Recent S&E Degree-Holders

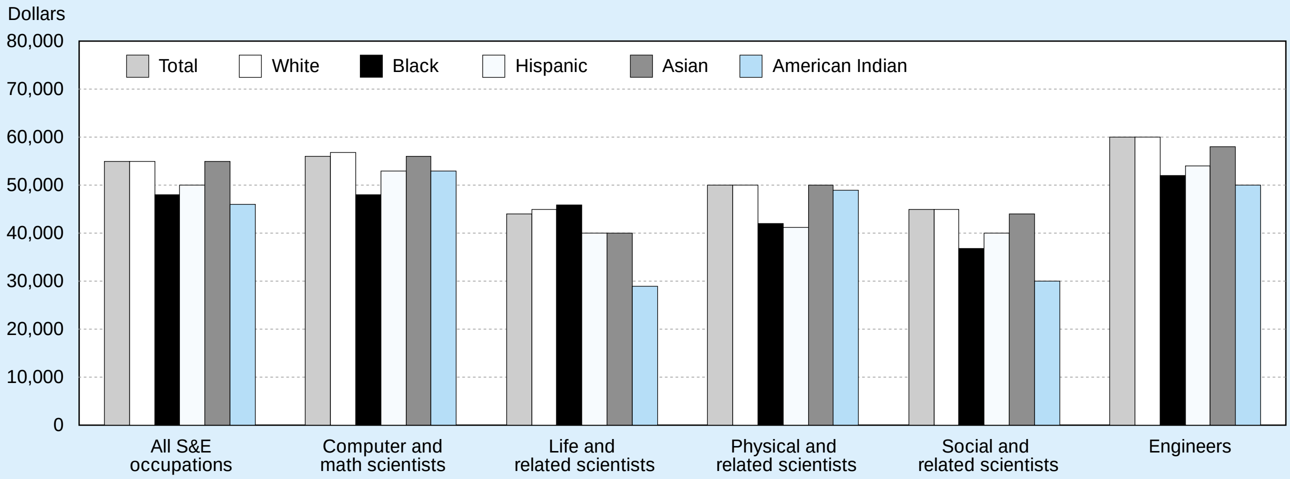
Bachelor's and Master's Degree Recipients[16]

Recent S&E bachelor's and master's degree recipients form a key component of the Nation's S&E workforce; they account for almost half the annual inflow to the S&E labor market. The career choices of recent graduates and their entry into the labor market affect the balance between the supply of and demand for scientists and engineers in the United States. Analysis of the workforce status and other characteristics of recent S&E graduates can yield valuable labor market information.

This section provides several labor market measures that offer useful insights into the overall supply and demand conditions for recent S&E graduates in the United States. Among these measures are median annual salaries, unemployment rates, and in-field employment rates.

[16]Data for this section are taken from the 1997 National Survey of Recent College Graduates. This survey collected information on the 1997 workforce-other status of 1995 and 1996 bachelor's and master's degree recipients in S&E fields. Surveys of recent S&E graduates have been conducted biennially for NSF since 1978. For information on standard errors associated with survey data, see NSF (in press, a).

Figure 3-11.
Median annual salaries of scientists and engineers, by broad occupation and race/ethnicity: 1997



NOTE: Individuals are characterized as scientists or engineers based on their current occupation.

See appendix table 3-16.

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Median Annual Salaries

In 1997, the highest median annual salaries for recent full-time employed graduates with bachelor's degrees in the sciences went to those with degrees in computer and information sciences ($37,700), and the highest salaries among those with degrees in engineering went to those with degrees in electrical, electronics, computer, and communications engineering ($40,500). (See appendix table 3-18.)

The same pattern was true among recent graduates with master's degrees. The highest median annual salaries went to graduates with master's degrees in computer and information sciences ($51,200) and electronics, computer, and communications engineering ($55,000).

School versus Employment

Approximately one-fifth of 1995 and 1996 bachelor's and master's graduates were enrolled in graduate school on a full-time basis in 1997. Students who had majored in the physical and related sciences and the life and related sciences were more likely to be in graduate school as full-time students than were graduates with degrees in computer and information sciences or engineering. (See appendix table 3-18.)

Employment Related to Field of Degree

Although individuals use college degrees to enter a wide variety of career paths, the extent to which their employment is related to their degrees may be one indicator of the vocational relevance of a degree. Across all fields of S&E in 1997, 70.4 percent of recent bachelor's degree graduates and 91.4 percent of recent master's degree graduates said their jobs were related to their field of degree (appendix tables 3-3 and 3-4). At the bachelor's level, employment related to field of degree for recent S&E graduates varied from 58.8 percent in the social sciences to 92.9 percent in computer sciences and 89.3 percent in engineering. At the master's degree level, there is much less variation by field of degree—ranging from 87.6 percent of recent master's degree graduates in social sciences saying their jobs are related to their degrees, to 97.9 percent of recent computer sciences master's degree graduates.

Employment Sectors

The private, for-profit sector is by far the largest employer of recent bachelor's and master's S&E degree recipients. (See text table 3-5.) In 1997, 66 percent of bachelor's degree recipients and 59 percent of master's degree recipients were employed in private, for-profit companies. The academic sector has been the second largest employer of recent S&E graduates. Master's degree recipients were more likely to be employed in four-year colleges and universities (9 percent) than were bachelor's degree recipients (5 percent). The Federal sector employed only 7 percent of S&E master's degree recipients and 4 percent of S&E bachelor's degree recipients in 1997. Engineering graduates are more likely to find employment in the Federal sector than science graduates. Other sectors employing small numbers of recent S&E graduates include educational institutions other than four-year colleges and universities, nonprofit organizations, and state and local government agencies.

Recent Doctoral Degree Recipients

Concerns about the labor market for workers with doctorates in S&E often focus on recent Ph.D. recipients entering the labor market and attempting to begin a career. Although the vast majority of S&E Ph.D. recipients find work that is related to their degrees, there is concern that fewer opportunities may make doctoral level science careers less desirable.

Text table 3–5.
Percentage of employed 1995 and 1996 S&E bachelor's and master's degree recipients, by sector of employment and field of degree: 1997

		Sector of employment[b]						
		Educational		Noneducational institutions				
Degree and field[a]	Total employed (thousands)	4-year college and university	Other educational institutions	Private for-profit company	Self-employed	Nonprofit organization	Federal Government	State or local government
	Percentage distribution							
Bachelor's recipients								
S&E	524.4	5	9	66	7	2	4	7
All sciences	428.4	6	11	62	8	2	3	8
All engineering	96.0	2	2	85	1	1	7	3
Master's recipients								
S&E	113.6	9	10	59	7	2	7	6
All sciences	74.4	12	15	49	10	2	6	6
All engineering	39.2	5	<1	79	1	1	9	4

[a] For graduates with more than one eligible degree at the same level (bachelor's or master's), the degree for which the graduate was sampled was used.

[b] This is the sector of employment in which the respondent was working on his or her primary job held on April 15, 1997. In this categorization, those working in four-year colleges and universities or university-affiliated medical schools or research organizations were classified as employed in the "four-year college and university" sector. Those working in elementary, middle, secondary, or two-year colleges or other educational institutions were categorized in the group "other educational." Those reporting that they were self-employed but in an incorporated business were classified in the private, for-profit sector.

NOTE: Details may not add to totals because of rounding. Percentages were calculated on unrounded data.

SOURCE: National Science Foundation, Division of Science Resources Studies (NSF/SRS), *National Survey of Recent College Graduates, 1997.*

Science & Engineering Indicators – 2000

Since the 1950s, the Federal Government has actively encouraged graduate training in science through a number of mechanisms. Real or perceived labor market difficulties for new Ph.D. scientists and engineers, however, could have various adverse effects on the health of scientific research in the United States. If labor market difficulties are real but temporary, promising students may be discouraged from pursuing degrees in S&E fields. Eventually, this circumstance could reduce the ability of industry, academia, and government to perform R&D, transfer knowledge, or perform many of the other functions of scientists in the modern economy. If labor market difficulties are long term, restructuring may need to take place within graduate education both to maintain high-quality research and to prepare students better for a wider range of career options. In either case, when much high-level human capital goes unused, society loses opportunities for new knowledge and economic advancement, and individuals feel frustrated in their careers.

Most individuals who complete an S&E doctorate are looking for more than just steady employment at a good salary. Their technical and problem-solving skills make them highly employable, but the opportunity to do the type of work they want and for which they have been trained is important to them. For that reason, no single measure can describe well the S&E labor market. Some of the available labor market indicators are discussed below.[17]

Aggregate measures of labor market conditions changed only slightly for recent doctorate recipients in S&E (defined here as those one to three years after their degree). Unemployment fell from 1.9 percent for a similar graduation cohort in 1995 to 1.5 percent in 1997. (See text table 3-6.) At the same time, the proportion of recent Ph.D. recipients reporting that they were either working outside their field because a job in their field was not available, or that they were involuntarily working part-time, rose slightly from 4.3 percent to 4.5 percent. These aggregate numbers mask a number of changes—both positive and negative—in a number of individual disciplines. In addition, in many fields the involuntarily out of field (IOF) and unemployment rates moved in opposite directions. In many ways, whether highly skilled individuals who are unable to get the type of employment they desire become unemployed or accept employment outside their field, may reflect the type of expectations they have of the labor market.

Unemployment Rates

Even compared to relatively good labor market conditions in the general economy, the 1.5 percent unemployment rate for recent S&E Ph.D. recipients is very low—the April 1997 unemployment rate for all civilian workers was 5.0 percent. (See the sidebar, "Data on Recent Ph.D. Recipients in Professional Society Data.")[18] In 1995, recent graduates in several

[17]Data on recent Ph.D. recipients presented here comes from the NSF/SRS 1993, 1995, and 1997 Survey of Doctorate Recipients, a component of the SESTAT data file that contains a 1/11 sample of S&E Ph.D. holders from U.S. schools. Ph.D. holders from foreign institutions were not included.

[18]People are said to be unemployed if they were not employed during the week of April 15, 1997, and had either looked for work during the preceding four weeks or were on layoff from a job. Although slightly different questions are used in the SESTAT surveys, this closely approximates the definition of unemployment used by the Bureau of Labor Statistics.

Text table 3–6.
Labor market rates for recent Ph.D. recipients: 1995 and 1997

	1–3 years after Ph.D.			
	Unemployment rate		Involuntary out-of-field rate	
Field	1995	1997	1995	1997
All S&E	1.9	1.5	4.3	4.5
Engineering	1.7	1.0	3.7	3.6
Chemical engineering	4.4	1.7	3.6	5.8
Civil engineering	1.2	0.0	1.1	5.5
Electrical engineering	0.9	0.6	3.1	3.2
Mechanical engineering	2.8	0.5	4.8	2.7
Other engineering	1.6	1.6	5.2	3.0
Life sciences	2.0	1.7	2.6	2.6
Agriculture	1.1	2.2	2.2	7.3
Biological sciences	2.0	1.5	2.7	2.2
Computer/math sciences	2.6	0.6	6.1	6.5
Computer sciences	1.1	0.7	2.7	2.1
Mathematical sciences	3.9	0.6	9.2	11.0
Physical sciences	2.4	2.1	5.3	6.9
Chemistry	2.2	3.5	4.1	3.3
Geosciences	1.7	1.0	6.8	6.3
Physics/astronomy	3.0	0.7	6.7	12.2
Social sciences	1.4	1.6	5.5	5.4
Economics	1.4	0.9	2.6	5.2
Political science	2.4	2.6	11.2	7.9
Psychology	0.5	1.2	3.8	3.8
Sociology/anthropology	3.1	2.5	9.0	7.7
Other social sciences	2.5	2.5	6.8	7.1

SOURCE: National Science Foundation, Division of Science Resources Studies (NSF/SRS), 1995 and 1997 Survey of Doctorate Recipients.

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Data on Recent Ph.D. Recipients in Professional Society Data

In 1998, data from surveys of new Ph.D. recipients for 1996–97 conducted by 13 S&E professional societies on 14 different disciplines were coordinated by the Commission on Professionals in Science and Technology. A common set of core questions was used in each society's poll of its own doctoral graduates to allow for collection of comparable career-related data. One of these common data elements, the unemployment rate is shown in text table 3-7. Unemployment ranged from 1.8 percent for recent physics Ph.D. recipients to 7.0 percent for recent Ph.D. recipients in political science.

Text table 3–7.
Unemployment rates for recent Ph.D. recipients reported in professional society surveys

Field	1995–96 Ph.D. recipients in 1997	1996–97 Ph.D. recipients in 1998
Biochemistry and molecular biology	NA	4.0
Chemistry	4	4.6
Chemical engineering	2	3.2
Computer science	2	2.4
Earth and space science	3	3.9
Economics	NA	2.3
Engineering	NA	2.7
Mathematics	5	2.4
Microbiology	NA	2.2
Physics	3	1.8
Physiology	NA	2.7
Political science	NA	7.0
Sociology	NA	1.9

NA = not available.

NOTE: Data for 1997 and 1998 were reported with different numbers of significant digits.

SOURCE: Commission on Professionals in Science and Technology.

Ph.D. disciplines had unemployment rates above 3 percent—still low, but unusually high for a highly skilled group. Between 1995 and 1997, unemployment rates fell for recent Ph.D. recipients in most disciplines, but increased in a few. The largest increase was in chemistry, where the unemployment rate for recent Ph.D. recipients rose from 2.2 to 3.5 percent—also making chemistry the field with the greatest unemployment rate for recent Ph.D. recipients. In 1997 unemployment rates of less than 1 percent were found for recent Ph.D. recipients in civil engineering (0.0 percent),[19] mechanical engineering (0.5 percent), electrical engineering (0.6 percent), mathematical sciences (0.6 percent), computer sciences (0.7 percent), physics-astronomy (0.7 percent), and economics (0.9 percent).

Involuntarily Working Outside Field

Another 4.5 percent of recent S&E Ph.D. recipients in the labor force reported that they could not find full-time employment (if they wished full-time employment) that was “closely related” or “somewhat related” to their degrees.[20] Although this is a more subjective measure than unemployment rates, it often provides a more sensitive indicator of labor market difficulties for a highly educated and employable population. It is best used, however, along with the unemployment rate as measures of two different forms of labor market distress.

The highest IOF rates in 1997 were found for recent Ph.D. graduates in physics-astronomy (12.2 percent) and in mathematical sciences (11.0 percent). These two fields also had among the lowest unemployment rates, although in physics-astronomy the increase in the IOF rate from 1995 to 1997 was much greater than the decrease in unemployment. The lowest IOF rates were found in computer sciences (2.1 percent) and the biological sciences (2.2 percent).

Tenure-Track Positions

Most S&E Ph.D. recipients do not ultimately work in academia—in most S&E fields this has been true for several decades. (Also see chapter 6, “Academic Research and Development: Financial and Personnel Resources, Support for Graduate Education, and Outputs.”) In 1997, of S&E Ph.D. recipients four to six years after receipt of their degrees, only 22.9 percent were in tenure track or tenured positions at four-year institutions of higher education. (See text table 3-8.) Across fields, tenure-program academic employment four to six years after Ph.D. ranged from 11.9 percent in chemical engineering to 51.2 percent in sociology-anthropology. For Ph.D. recipients one to three years after their degrees, only 16.0 percent were in tenure programs, but this reflects the

[19]An unemployment rate of 0.0 does not mean that no one in that field was unemployed, but that the estimated rate from NSF’s sample survey was less than 0.05 percent.

[20]People were considered as working involuntarily outside their field if they said their jobs were not related to their degrees and they said that one reason was because no job in their field was available, or if they were part-time and said that the only reason was because a full-time job was not available. The involuntarily out of field rate (IOF) is calculated as the percentage that such individuals are of those in the labor force.

Text table 3–8.
Percentage holding tenure and tenure-track appointments at four-year institutions: comparison of recent Ph.D. recipients: 1993, 1995, and 1997

	Recent Ph.D. recipients, tenured or tenure-track at four-year institutions					
	Years since receipt of Ph.D.					
	1995		1995		1997	
Field	1–3 years	4–6 years	1–3 years	4–6 years	1–3 years	4–6 years
All S&E	18.4	26.6	15.6	26.3	16.0	22.9
Engineering	16.0	24.6	12.7	20.5	10.9	17.8
Chemical engineering	8.1	14.0	6.1	5.5	2.8	11.9
Civil engineering	24.7	27.1	25.6	29.3	24.8	23.0
Electrical engineering	17.6	26.9	10.6	21.5	8.3	16.6
Mechanical engineering	13.5	29.5	14.5	25.4	9.1	14.4
Other engineering	13.9	21.3	10.5	17.3	12.5	18.5
Life sciences	12.6	24.8	12.6	24.0	12.6	22.4
Agriculture	15.6	27.0	13.5	25.0	21.6	24.3
Biological sciences	12.1	24.8	12.5	23.7	11.7	22.3
Computer/math sciences	39.7	54.1	34.8	47.3	27.9	37.8
Computer sciences	37.1	51.5	34.3	41.5	28.4	33.3
Mathematical sciences	41.8	56.0	35.2	52.6	27.3	41.2
Physical sciences	9.7	18.2	7.3	17.2	7.6	17.6
Chemistry	7.7	16.3	6.8	14.6	6.4	16.8
Geosciences	12.7	26.2	10.8	29.7	18.4	29.5
Physics/astronomy	12.0	17.7	5.8	15.2	4.6	15.0
Social sciences	26.4	29.2	21.5	33.6	25.1	27.1
Economics	46.6	48.6	41.7	54.5	34.8	48.0
Political science	53.9	47.1	29.5	66.1	40.5	39.0
Psychology	12.7	15.5	12.7	19.4	13.0	15.8
Sociology/anthropology	37.9	46.9	30.8	48.3	35.3	51.2
Other social sciences	37.4	48.8	27.3	41.4	39.7	33.5

SOURCE: National Science Foundation, Division of Science Resource Studies (NSF/SRS), 1993, 1995, and 1997 Survey of Doctorate Recipients.

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increasing use of postdoctoral appointments (or postdocs) by recent Ph.D. recipients in many fields.

Although academia must be considered just one possible sector of employment for S&E Ph.D. recipients, the availability of tenure-track positions is an important aspect of the job market for those who do seek academic careers. The rate of tenure-program employment for those four to six years since receipt of Ph.D. fell from 26.6 percent in 1993 to 22.9 percent in 1997, which reflects both job opportunities in academia and alternate opportunities for employment. For example, one of the largest declines in tenure-program employment occurred in computer sciences (from 51.5 percent in 1993 to 33.3 percent in 1997) where other measures of labor market distress are low and organizations of computer science departments report difficulties recruiting faculty.[21] The attractiveness of other employment may also be an explanation for drops in tenure-program rates in several engineering disciplines. The attractiveness of alternate employment, however, is a less likely explanation for the smaller drops in tenure-program employment rates in fields with other measures of distress, such as physics and mathematical sciences (both of which have large IOF rates) and the biological sciences (which have low unemployment and IOF rates, but have other indications of labor market distress).

Relationship Between 1997 Occupation and Field of Degree

By a strict definition of occupational titles, 15.0 percent of employed recent Ph.D. recipients were in occupations outside S&E, often with administrative or management functions. When asked how related their jobs were to their highest degree, only a small proportion of recent Ph.D. recipients in non-S&E occupations said that their jobs were unrelated to their degrees. (See text table 3-9.) By field, these respondents ranged from 1.4 percent of recent psychology and computer science Ph.D. graduates to 6.3 percent of recent Ph.D. graduates in mathematical sciences.

[21]See Freeman and Aspray (1997).

Salary for Recent S&E Ph.D. Recipients

Across all fields of degree, the median salary for recent S&E Ph.D. recipients was $41,000, a increase of 2.5 percent from 1995. By field, this ranges from a low of $32,000 in the biological sciences to a high of $68,000 in electrical engineering. Text table 3-10 shows the distribution of salaries for recent Ph.D. recipients by field of degree. For all Ph.D. recipients, those at the top 10 percent of the salary distribution (the 90th percentile) were paid $71,000. (See text table 3-10.) The 90th percentile salary varied by field from a low of $55,000 for sociology-anthropology to a high of $86,000 for computer science Ph.D. recipients. At the 10th percentile, representing the lowest-paid 10 percent among each field, salaries ranged from $16,000 for sociology-anthropology Ph.D. recipients to $45,000 for industrial engineering.

Salaries for recent S&E Ph.D. recipients by sector of employment are given in text table 3-11. The median salary for a postdoc one to three years after receipt of degree was $28,000—about half the median for a recent Ph.D. recipient working for a private company ($60,000). Many of the salary differentials between different S&E fields are narrower when examined within sector of employment. For those in tenure-track positions, median salaries ranged from about $37,000 in mathematical sciences to $50,000 for computer S&E. At private for-profit companies, median salaries ranged from $43,000 for psychology to $72,000 for computer science.

Changes in median salaries for recent (defined here as one to five years after receipt of degree) bachelor's, master's, and Ph.D. graduates are shown in text table 3-12. Across all S&E fields, median salaries for Ph.D. recipients rose by just 2.3 percent from 1995 to 1997—compared with 11.1 percent for bachelor's and 10.0 percent for master's degree graduates. To a considerable extent however, the median salary across all fields of Ph.D. was held down by relatively more rapid growth in Ph.D.

Text table 3–9.
Recent Ph.D. scientists and engineers, by field of degree and relationship between field of study and occupation: 1997
(Percent)

	Employed Recent Ph.D.				
Field	Total	Same field	Other S&E	Related non-S&E	Nonrelated, Non-S&E
All S&E	100.0	71.9	13.1	12.3	2.8
Computer sciences	100.0	83.4	3.0	12.2	1.4
Engineering	100.0	75.0	17.8	5.5	1.7
Life sciences	100.0	71.8	6.3	19.2	2.7
Mathematical sciences	100.0	70.6	14.9	8.2	6.3
Other social sciences	100.0	67.7	5.2	22.1	4.9
Physical sciences	100.0	72.0	20.5	4.5	3.0
Psychology	100.0	68.0	21.9	8.7	1.4

SOURCE: National Science Foundation, Division of Science Resources Studies (NSF/SRS), 1997 Survey of Doctorate Recipients.

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Text table 3–10.
Salary distribution for recent Ph.D. recipients: 1997

Field	Percentile 10th	25th	Median	75th	90th
Total recent S&E Ph.D.	$24,000	$30,000	$41,000	$58,000	$71,000
Computer/math, total	32,000	37,500	50,000	68,000	80,000
Computer sciences	37,500	46,000	60,000	72,250	86,000
Mathematical sciences	30,000	34,000	40,000	52,500	70,000
Life sciences, total	22,000	26,000	32,300	45,600	60,000
Agriculture	20,500	28,000	38,900	49,000	58,000
Biological sciences	22,000	25,600	32,000	45,000	60,000
Health/medical	25,000	35,000	40,500	51,500	61,000
Physical sciences, total	24,000	31,000	41,500	58,000	67,000
Chemistry	22,000	27,000	40,000	58,000	65,000
Geosciences	29,000	33,000	39,860	48,000	63,000
Physics/astronony	27,150	35,000	43,070	60,000	70,000
Social sciences, total	20,000	31,000	40,000	49,000	64,000
Economics	30,000	43,000	50,000	64,500	80,000
Political science	21,000	33,000	40,000	47,000	65,000
Psychology	20,000	30,000	38,000	46,700	60,000
Sociology/anthropology	16,000	30,000	37,000	43,495	55,000
Other social sciences	20,000	33,500	39,000	46,500	61,000
Engineering, total	35,000	49,000	60,000	70,000	80,000
Aerospace engineering	39,000	50,000	56,000	65,000	70,000
Chemical engineering	30,000	49,000	60,000	68,000	76,100
Civil engineering	31,500	40,000	48,000	56,000	72,000
Electrical engineering	44,000	55,760	68,000	75,000	85,000
Industrial engineering	45,000	52,500	60,000	70,000	80,000
Mechanical engineering	40,000	48,800	58,540	69,000	76,000
Other engineering	30,000	43,000	55,000	65,000	74,300

SOURCE: National Science Foundation, Division of Science Resource Studies (NSF/SRS), 1993, 1995, and 1997 Survey of Doctorate Recipients.

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Text table 3–11.
Median salaries for recent U.S. Ph.D. recipients, by sector of employment: 1997

Field	Total	Private/ noneducational	Government	Tenure-track at four-year institution	Postdoc	Other educational
Total	$41,000	$60,000	$53,000	$42,000	$28,000	$36,000
Computer sciences	60,000	72,000	—	50,000	—	—
Engineering	60,000	65,000	60,000	50,000	35,000	48,000
Life sciences	32,300	55,000	50,000	42,300	27,000	35,000
Math sciences	40,000	60,000	—	37,150	—	35,000
Social sciences (other than psychology)	40,000	53,000	52,400	40,000	30,500	35,000
Physical sciences	41,500	60,000	57,300	39,000	32,000	35,000
Psychology	38,000	43,000	45,000	38,000	26,700	36,000

— = Fewer than 50 cases.

SOURCE: National Science Foundation, Division of Science Resource Studies (NSF/SRS), 1993, 1995, and 1997 Survey of Doctorate Recipients.

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Text table 3–12.
Change in median salaries for S&E graduates one to five years after degree: percentage change between 1995 and 1997

Field	Bachelor's	Master's	Ph.D.
All S&E Fields	11.1	10.0	2.3
Engineering	8.1	6.4	7.1
Chemical engineering	2.4	6.4	1.6
Civil engineering	2.9	8.0	–3.8
Electrical engineering	13.2	10.0	15.8
Mechanical engineering	5.3	11.1	9.1
Life sciences	4.2	6.7	–1.7
Agricultural sciences	4.2	6.9	0.0
Biological sciences	6.4	6.7	6.6
Computer/math sciences	12.8	12.4	14.6
Computer sciences	16.0	12.5	11.7
Mathematical sciences	8.9	14.3	5.3
Physical sciences	10.1	2.8	9.3
Chemistry	-3.6	0.0	2.0
Geoscience	16.7	0.0	2.5
Physics	41.7	20.0	17.5
Social sciences	8.3	5.8	5.0
Economics	10.0	20.0	10.0
Political science	12.0	11.8	6.2
Psychology	14.3	4.3	0.0
Sociology/anthropology	9.1	1.8	–2.7

SOURCE: National Science Foundation, Division of Science Resources Studies (NSF/SRS), 1995 and 1997 SESTAT data file.

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Text table 3–13.
Percentage of recent S&E graduates who say they are "not at all likely" to choose the same field of study if they could do it over again (one to five years after degree)

Field	Bachelor's	Master's	Ph.D.
All S&E fields	20.2	12.6	16.6
Engineering	11.3	12.6	14.8
Chemical engineering	9.5	13.1	13.0
Civil engineering	14.2	16.6	20.9
Electrical engineering	8.3	6.5	9.8
Mechanical engineering	10.2	16.6	16.5
Life sciences	16.8	13.9	18.3
Agricultural sciences	20.7	18.4	20.7
Biological sciences	16.0	14.0	18.2
Computer/math sciences	8.9	6.6	14.5
Computer sciences	6.8	5.3	6.8
Mathematical sciences	12.0	10.3	22.4
Physical sciences	16.1	18.6	23.3
Chemistry	15.7	27.2	23.9
Geoscience	25.2	12.5	20.3
Physics	9.7	17.0	24.4
Social sciences	27.3	14.3	12.5
Economics	23.7	11.8	12.6
Political science	25.5	19.6	13.3
Psychology	28.4	13.7	10.8
Sociology/anthropology	31.2	15.7	15.5

SOURCE: National Science Foundation, Division of Science Resources Studies (NSF/SRS),1995 and 1997 SESTAT data file.

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production in lower-paying fields, such as the biological and social sciences. Much larger increases were found in most individual disciplines, including double-digit increases in physics (17.5 percent), electrical engineering (15.8 percent), computer sciences (11.7 percent), and economics (10.0 percent). Declines in median salaries were observed in civil engineering (–3.8 percent) and sociology-anthropology (–2.7 percent).

Happiness with Choice of Field of Study

One indicator of the quality of employment available to recent graduates is simply their answer to this question: If you had the chance to do it over again, how likely is it that you would choose the same field of study for your highest degree? When this was asked of those with S&E degrees received 1–5 years after their previous degree, 16.6 percent of Ph.D. recipients said they were "not at all likely" as compared with 20.2 percent of those with S&E bachelor's degrees. (See text table 3-13.) This regret of field choice is lowest for recent Ph.D. recipients in computer sciences (6.8 percent) and electrical engineering (9.8 percent), and in the social sciences (12.5 percent). It is greatest in physics (24.4 percent), chemistry (23.9 percent), and mathematical sciences (22.4 percent).

Postdoctoral Appointments

A postdoctoral appointment (or postdoc) is defined here as a temporary position awarded in academia, industry, or government primarily for the purpose of gaining additional training in research. This definition has been used in the Survey of Doctorate Recipients to ask respondents about current and past postdoctorate positions they have held.[22] Data and analyses on postdoctorates are often examined in relation to recent Ph.D. labor market issues. In addition to gaining more training, recent Ph.D. recipients may accept a temporary, usually lower-paying, postdoctorate position because a more permanent job in their field is not available. The increasing use of postdocs has been a focal point of discussions about many inter-related topics—the early career paths for new Ph.D. scientists, the vocational adequacy of Ph.D. programs, and the labor market expectations of new Ph.D. recipients.[23]

Science & Engineering Indicators – 1998 included an analysis of a one-time postdoctorate module in the 1995 Survey of Doctorate Recipients that showed a slow increase the use of postdocs in many disciplines over time.[24] In addition, in physics and the biological sciences, the fields with the heavi-

[22]It is clear, however, that the exact use of the term "postdoctorate" differs among academic disciplines, among different universities, and among the different sectors that employ postdoctorates. It is likely that these differences in labeling affected self-reporting of postdoctorate status on the Survey of Doctorate Recipients.

[23]A recent overview of issues related to postdocs was published in *Science*, September 3, 1999, "Postdocs: Working for Respect."

[24]This was measured cross-sectionally by looking at the percentage of each graduation cohort that reported ever being in a postdoc position.

Text table 3-14.
Primary reason for taking current postdoc: 1997
(Percent)

Field	Additional training in Ph.D. field	Training outside of Ph.D. field	Postdoc generally expected in field	Work with a particular person or place	Other employment not available	Other
Biological sciences	20.1	14.7	28.1	18.7	13.5	5.0
Chemistry	21.0	13.5	25.3	14.1	25.3	7.7
Engineering	18.4	12.9	7.0	20.7	23.1	17.9
Geoscience	29.4	3.5	18.3	7.6	29.3	11.9
Physics	13.7	8.4	34.4	16.7	19.1	7.6
Psychology	29.1	9.7	21.3	19.4	12.4	8.1
All S&E fields	20.0	13.325	23.7	18.3	17.2	7.5

SOURCE: National Science Foundation, Division of Science Resources Studies (NSF/SRS), Survey of Doctorate Recipients, 1997.

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est use of postdocs, median time in postdoc positions extended well beyond the one to two years found in most other fields.

Data from 1997 show a small decline in the percentage of all recent S&E Ph.D. recipients entering postdoc positions—from 32.7 percent of 1994 graduates in 1995 to 30.7 percent of 1996 graduates in 1997. At the same time, however, Ph.D. recipients in earlier graduation cohorts in these two fields show a similar propensity to be in postdocs as those with the same years since degree in 1995. Speculatively, something like this might be observed if new graduates were the most affected by improvements in labor market conditions. In fields other than physics or biological sciences, the postdoc rate one year after degree fell only slightly, from 21.2 percent in 1995 to 19.9 percent in 1997.

Reasons for Taking a Postdoc

Postdocs in 1997 were asked to provide reasons they were in their current postdoctoral appointment—the distribution of "primary reasons" given is shown in text table 3-14. Across all fields of degree, 17.2 percent gave "other employment not available" as the primary reason they were in a postdoc. Most respondents gave as primary reasons that a postdoc was generally expected for a career in their field (23.7 percent), that they were seeking additional training either in or outside of their Ph.D. field (20.0 and 13.3 percent), or other reasons more consistent with the stated training and apprenticeship functions of postdocs.[25]

Postdoc Transitions: What Were 1995 Postdocs Doing in 1997?

Of those in postdoctorate positions in April 1995, 38.0 percent were still in a postdoctorate position in April 1997. (See text table 3-15.) This is a small reduction from the 41.6 percent of 1993 postdocs that were still postdocs in 1995. (See *Science and Engineering Indicators 1998*.) Only 16.5 percent had moved from a postdoctorate to a tenure-track position at a four-year educational institution (up from 12.1 percent in 1995); 18.3 percent found other employment at an educational institution; 18.0 percent were at a for-profit firm;

[25]Respondents may well have defined their field in far narrower terms than reported here. Hence "training out of field" may refer to a biologist doing postdoc research on a topic different from their dissertation as opposed to doing a postdoc in chemistry.

Text table 3–15.
What were 1995 postdocs doing in 1997?
(Percent)

Field	Postdoc	Tenure-track at four-year institution	Other education	For-profit	Nonprofit / government	Unemployed
Biological sciences	49.3	14.0	17.9	12.4	5.4	1.0
Chemistry	23.1	16.8	20.4	26.5	6.1	7.1
Engineering	26.8	12.9	10.4	38.4	9.1	2.4
Physics	33.1	16.6	16.5	23.2	10.4	0.1
Psychology	17.2	14.8	23.1	27.1	17.7	0.0
All S&E fields	38.0	16.5	18.3	18.0	7.7	1.5

SOURCE: National Science Foundation, Division of Science Resources Studies (NSF/SRS), merged 1995 and 1997 file from NSF's Survey of Doctorate Recipients.

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7.7 percent were employed at a nonprofit institution or government; and 1.5 percent were unemployed.

No information is available on the career intentions of those in postdoc positions, but it is often assumed that a postdoc is most valued by academic departments at research universities. More postdocs, however, in each field transition to for-profit employment than obtain tenure-track positions—and many tenure-track positions are at schools where a research record obtained through a postdoc appointment may not be of central importance.

Age and Retirement

The size of the S&E labor force, its productivity, and opportunities for new S&E workers are all greatly affected by the age distribution and retirement patterns of the S&E labor force. For many decades, rapid increases in new entries to the S&E labor force led to a relatively young S&E labor force with only a small percentage near traditional retirement ages. This general picture is rapidly changing as the large number of individuals who earned S&E degrees in the late 1960s and early 1970s are moving into what is likely to be the latter part of their careers.

The possible effects of age distribution on scientific productivity are controversial. Increasing average ages may mean increased levels of experience and productivity among scientific workers. Others have argued that it can reduce the opportunities for younger scientists to perform independent work. Indeed, in many fields there is scientific folklore and some actual evidence indicate that the most creative research comes from the young. The ongoing research in cognitive aspects of aging and the sociology of science is relevant to this debate, but will not be reviewed here.[26]

Age

Age distributions for scientists and engineers in the labor force are affected by many factors—net immigration, morbidity, and mortality—but most of all by historical S&E degree production patterns. Age distributions for individuals with S&E degrees in 1997 are given by degree level and field of degree in appendix table 3-19. With the exception of new fields, such as computer sciences (where 70.0 percent of degree holders are under age 40), the greatest population density of individuals with S&E degrees occurs between ages 40 and 49. This can be seen in figure 3-12, which shows the age distribution of the S&E educated labor force broken down by level of degree. For all S&E degrees there is also a bump up in the age distribution at ages 25–29 representing 14.2 percent of S&E degree holders in the labor force. This bump up, however, appears to be largely caused by increased degree production in the social sciences (where 25- to 29-year-olds represent 17.7 percent of the total). In general, most of the S&E degreed labor force is their late 30s through early 50s.

[26]See Stephan and Levin (1992) and Posner (1995) for a discussion of the role of age for scientists and other creative workers.

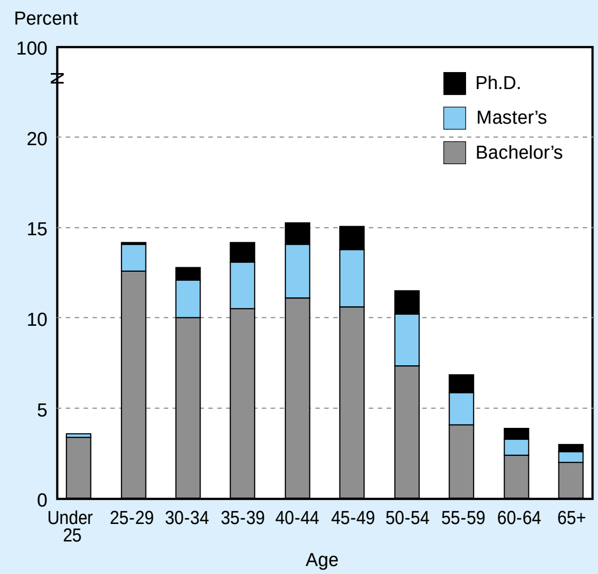
This general pattern holds true even for those with doctorates in S&E. Although Ph.D. holders are somewhat older than other S&E degree holders, this circumstance is because of fewer Ph.D. holders in the younger age categories, given the time needed to obtain this degree. The greatest population density of S&E Ph.D. holders in the labor force occurs for 45- to 54-year-olds.

S&E Ph.D. holders employed in tenured or tenure-track positions in four-year institutions of higher education (26.9 percent of all S&E Ph.D. holders) are somewhat older than all S&E Ph.D. holders—31.5 percent older than age 54 compared to 25.8 percent. (See figure 3-13.) The greatest population density of Ph.D. holders in these tenure programs occurs between ages 40 and 59. It is worth noting the sharp differences between the 55–59 and 60–64 age categories for both academic Ph.D. holders and the S&E Ph.D. population as a whole—a 48 percent drop that is much steeper than for the bachelor's or master's degreed S&E population.

At all degree levels and fields, only a small proportion of the S&E degreed labor force was near traditional retirement ages—only 13.6 percent overall were over age 54. This has several likely important and often overlooked effects on the future S&E labor force:

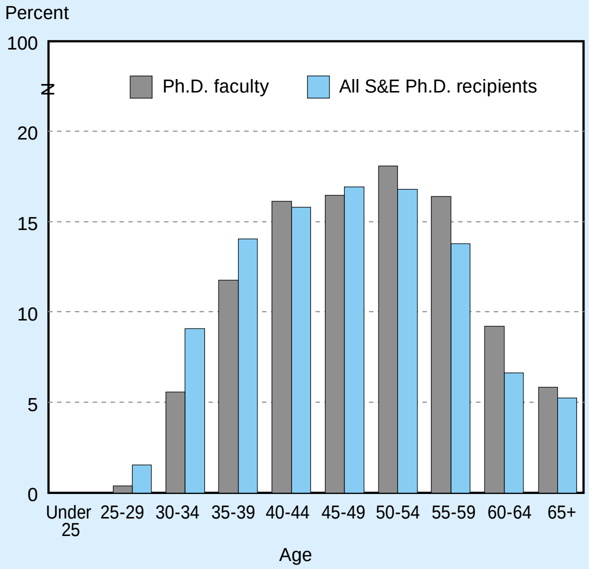
- Barring very large reductions in degree production or similarly large increases in retirement rates, the number of trained scientists and engineers in the labor force will continue to increase for some time. The number of individuals who are now receiving S&E degrees greatly exceeds the number of S&E degreed workers who are near traditional retirement ages.

Figure 3-12.
Age distribution of labor force with S&E high degrees



Unpublished tabulations. *Science & Engineering Indicators – 2000*

Figure 3-13.
1997 age distribution of S&E Ph.D. recipients in the labor force: tenured and tenure-track faculty at four-year institutions



See appendix table 3-21. *Science & Engineering Indicators – 2000*

- ♦ Barring large increases in degree production, the average age of S&E degreed workers will rise.
- ♦ With current retirement patterns, the total number of retirements among S&E degreed workers will dramatically increase over the next 10–15 years. This may be particularly true for Ph.D. holders because of the steepness of their age profile.

Retirement

Retirement behavior can differ in complex ways from one individual to the next. Some individuals “retire” from a job while continuing to work full- or part-time, sometimes for the same employer. Others leave the labor force without a “retired” designation from some formal pension plan. Three different ways of thinking about changes in labor force involvement are summarized in text table 3-16 for S&E degree holders—leaving full-time employment, leaving the labor force, and retiring from a particular job.

By age 63, 50 percent of S&E bachelor’s and master’s degree holders were not working full-time. For S&E Ph.D. holders, this 50 percent mark is not reached until three years later, at age 66. Longevity also differs by degree level with other measures. Half of S&E degree holders have left the labor force entirely by age 64 for bachelor’s degree holders, by age 65 for master’s degree holders, and not until age 68 for Ph.D. holders. Formal retirement also occurs at somewhat higher ages for Ph.D. holders—more than 50 percent of S&E bachelor’s and master’s degree holder’s have “retired” from some job by age 63, compared with age 65 for S&E Ph.D. holders.

Although many S&E degree holders who formally “retire” from one job continue to work full-time or part-time, this occurs most often among those under age 63. (See text table 3-17.) The drop in labor force participation among the “retired” is more pronounced for part-time work—older retired S&E workers are actually more likely to be working full-time than part-time. Retired Ph.D. scientists and engineers follow the same pattern, albeit with somewhat greater rates of post-retirement employment than bachelor’s and master’s degree holders.

Movement out of full-time employment by S&E degree holders aged 55–70 is shown in figure 3-14. At all degree levels, the proportion of S&E degree holders who work full-time declines fairly steadily by age. After age 55, full-time employment by S&E doctorates becomes significantly greater than for bachelor’s and master’s degree holders. At age 70, over 20 percent of S&E Ph.D. holders are working full-time, compared with 10 percent of bachelor’s and master’s.

Academic employment may be one reason for somewhat slower retirement among Ph.D. holders. Text table 3-18 looks at the rate at which S&E Ph.D. holders leave full-time em-

Text table 3-16.
Retirement ages for holders of S&E degrees

Highest degree	First age at which more than 50 percent are: Not working full-time	Not in labor force	Retired from any job
Bachelor’s	63	64	63
Master’s	63	65	63
Ph.D.	66	68	65

SOURCE: National Science Foundation, Division of Science Resources Studies (NSF/SRS), SESTAT data file, 1997.

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Text table 3-17.
Percentage of S&E degreed individuals who have “retired,” but continue to work: 1997

Age group	Bachelor’s Part-time	Bachelor’s Full-time	Master’s Part-time	Master’s Full-time	Ph.D. Part-time	Ph.D. Full-time
50–55	52.1	15.8	65.1	17.3	62.1	20.4
56–62	27.2	13.4	35.7	13.7	36.8	18.5
63–70	9.1	12.7	8.7	15.6	13.9	17.6
> 70	4.0	8.4	5.1	9.6	5.4	10.9

SOURCE: National Science Foundation, Division of Science Resources Studies (NSF/SRS), SESTAT data file, 1997.

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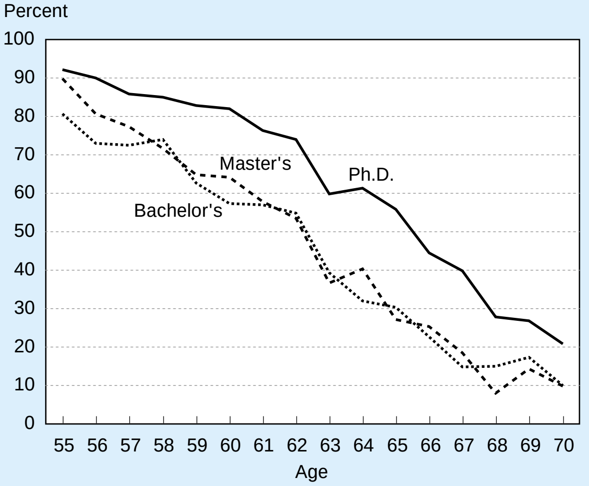
Figure 3-14.
Older S&E degree holders working full-time



See appendix table 3-22. *Science & Engineering Indicators – 2000*

Text table 3–18.
Percentage of 1995 S&E Ph.D.s leaving full-time employment by 1997: by sector of employment in 1995

Age in 1995	Four-year schools	For profit company	Govern-ment	All sectors
51–55	3.2	4.8	4.2	4.9
56–60	9.2	14.8	7.2	11.1
61–65	24.6	26.6	13.6	25.7
66–70	35.7	56.3	38.4	39.1
71–73	40.6	55.3	—	41.8

SOURCE: National Science Foundation, Division of Science Resources Studies (NSF/SRS), 1995 and 1997 Survey of Doctorate Recipients.

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ployment between 1995 and 1997 by sector of employment.[27] Within each age group, a smaller proportion of S&E Ph.D. holders employed in 1995 at four-year colleges and universities, or by the government, left full-time employment than S&E Ph.D. holders as a whole, or those employed by for-profit companies.

While slower retirement for S&E Ph.D. holders, particularly those in academia, is significant and of some policy interest, it is important to recognize that this does not mean that academic or other Ph.D. holders seldom retire. Indeed, figure 3-14 shows that their retirement patterns are much more like those of bachelor's and master's degree holders than they are different—retirement is just delayed two or three years. Even the two-year transition rates for academia in text table 3-18 shows more than a third of those aged 66–70 leaving full-time employment over a two-year period.

One reason academic Ph.D. retirement rates have been of interest has been a concern that the academic tenure system, combined with the end of mandatory retirement under U.S. antidiscrimination laws, could lead to continued employment of many less productive professors. Text table 3-19 compares two-year transition rates of leaving full-time employment for S&E Ph.D. holders employed full-time in 1995 at four-year institutions, by the number of articles they said they published within the previous five years. Within each age group, those writing six or more articles had a much lower transition rate out of full-time employment than those reporting fewer articles written. For those between the ages of 51 and 65, the transition rate for academics with zero articles was more than double the rate for those with six or more.

Projected Demand for S&E Workers

During the 1998–2008 period, employment in S&E occupations is expected to increase at almost four times the rate for all occupations. Though the economy as a whole is anticipated to provide approximately 14 percent more jobs over this decade, employment opportunities for S&E jobs are expected to increase by about 51 percent, or about 1.9 million jobs. (See text table 3-20.)

Approximately four-fifths of the increase in S&E jobs will occur in computer-related occupations. Overall employment in these occupations across all industries is expected to almost double over the 1998–2008 decade, with more than 1.5 million new jobs being added. Jobs for computer engineers and scientists are expected to increase from 914,000 to 1,858,000, while employment for computer systems analysts is expected to grow from 617,000 to almost 1.2 million jobs. (See the sidebar, "What Did Computer Workers Get Degrees In?")

Text table 3-19.
Percentage of 1995 S&E Ph.D. recipients at four-year institutions leaving full-time employment: by number of articles published in 1990–95

Age in 1995	No articles	1–5 articles	6 or more articles	All
51-55	5.7	3.5	1.0	3.2
56-60	12.2	8.6	6.7	9.2
61-65	32.6	23.5	16.1	24.6
66-70	—	43.1	28.0	35.7
71-73	—	—	28.1	40.6

— = Not available

SOURCE: National Science Foundation, Division of Science Resources Studies (NSF/SRS), 1995 and 1997 Survey of Doctorate Recipients.

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[27]As a practical matter, it would be difficult to calculate many of the measures of retirement used previously in this chapter by sector of employment. A two-year transition rate, however, can be calculated using the NSF/SRS SESTAT data file matched longitudinally at the individual level.

Text table 3-20.
Total S&E jobs: 1998 and projected 2008
(Numbers in thousands of jobs)

	1998	2008	Change
Total, all occupations	**140,514**	**160,795**	**20,281**
All S&E occupations	3,809	5,747	1,937
Scientists	2,347	3,995	1,647
Life scientists	173	219	45
Computer, mathematical, and operations research occupations	1,653	3,182	1,529
Computer systems analysts, engineers, and scientists	1,530	3,052	1,522
Computer engineers and scientists	914	1,858	944
Systems analysts	617	1,194	577
Mathematical scientists	123	131	8
Physical scientists	200	229	29
Social scientists	321	365	44
Engineers	1,462	1,752	290

See appendix table 3-28. *Science & Engineering Indicators – 2000*

Within engineering, electrical-electronic engineering is projected to have the biggest absolute and relative employment gains, up by 93,000 jobs, or about 26 percent. Civil and mechanical engineers are also expected to experience above-average employment gains, with projected increases of about 21 and 16 percent, respectively. Employment for all engineering occupations is expected to increase by an average of approximately 20 percent.

Job opportunities in life science occupations are projected to grow by 26 percent (45,000 new jobs) over the 1998–2008 period; at 35 percent, the biological sciences are expected to experience the largest growth (28,000 new jobs). Employment in physical science occupations is expected to increase by about 15 percent, from 200,000 to 229,000 jobs; slightly less than half of the projected job gains are for chemists (13,000 new jobs).

Social science occupations are expected to experience only average growth (14 percent) over the decade, largely because of the modest employment increases anticipated for psychologists (11 percent or 19,000 new jobs). Economists, however, are projected to experience more favorable job growth (19 percent or 13,000 new jobs).

Foreign-Born Scientists and Engineers in the United States

In April 1997, 26.1 percent of holders of doctorates in S&E in the United States were foreign born. This is shown in text table 3-22 with data from the 1997 NSF/SRS SESTAT data file, a large national sample of those with U.S. S&E degrees and those with foreign S&E degrees who were in the United

What Fields Did Computer Workers Get Degrees In?

In 1993 only 28.5 percent of college graduates employed in computer occupations had computer science degrees, with another 2.9 percent having degrees in the closely related field of computer and systems engineering and 6.7 percent in the sometimes closely related field of electrical engineering (text table 3-21).* Perhaps reflecting the role of business departments and schools in initially introducing computer training on many campuses, 17.7 percent had business degrees. Altogether, 32.5 percent of those in computer occupations in 1993 had degrees in fields outside science, engineering, or technology (SE&T), and another 29.6 percent had degrees in SE&T fields not directly related to computing. This picture is very different for computer workers under age 30: 45.2 percent have computer science degrees, 4.9 percent degrees in computer and systems engineering, and 8.9 percent in electrical engineering. Only 16.5 percent had degrees in non-SE&T fields.

*1993 is the only year in the 1990s for which both field of degree and occupation are available on a major workforce survey for all college graduates. The 1993 SESTAT file augmented with the non-S&E records from the 1993 National Survey of College Graduates provides a valid national sample for this population.

Text table 3–21.
Field of highest degree for 1993 computer job holders

	(Percent)		
Field of highest degree	All ages	Age < 30	Age 30+
Computer sciences	28.5	45.2	25.4
Mathematics	8.9	6.6	9.3
Life sciences	2.1	0.6	2.4
Physical sciences	3.5	2.0	3.8
Social sciences	7.0	6.5	7.1
Computer & systems engineering	2.9	4.9	2.5
Electrical engineering	6.7	8.9	6.3
Mechanical engineering	1.2	1.2	1.2
Other engineering	3.0	2.9	3.0
Business	17.7	10.5	19.0
Education	4.2	0.6	4.9
Technology	3.9	4.5	3.8
Humanities	6.1	2.7	6.7
Other non-S&E	4.5	2.7	4.8
Total (n = 1,243,300)	100.0	100.0	100.0

— = Data not available.

SOURCE: National Science Foundation, Division of Science Resources Studies (NSF/SRS), SESTAT Data file, 1993.

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Text table 3–22.
Percentage foreign-born, S&E trained U.S. scientists and engineers, by field of highest degree and degree level: 1997

Field of highest degree	Labor force, total	Bachelor's	Master's	Doctorate
All S&E	12.7	9.7	19.2	26.1
Engineering	19.8	14.9	30.1	44.0
Aerospace engineering	12.4	10.0	14.3	37.2
Chemical engineering	21.4	15.8	35.6	40.1
Civil engineering	21.2	16.5	33.8	52.0
Electrical engineering	22.7	18.0	32.2	46.8
Industrial engineering	16.9	11.2	32.3	50.9
Mechanical engineering	17.8	13.5	32.7	45.4
Other engineering	17.4	10.8	23.1	40.3
Life sciences	10.7	7.8	12.8	24.7
Agriculture	6.9	4.3	14.4	21.7
Biological sciences	12.3	9.3	13.0	25.5
Math/computer sciences	16.5	12.7	24.6	35.6
Computer sciences	20.4	15.6	30.8	49.5
Mathematical sciences	11.8	9.4	14.8	30.7
Physical sciences	16.0	11.8	17.2	28.5
Chemistry	20.0	15.9	23.9	29.1
Geosciences	8.0	5.4	10.2	19.5
Physics/astronomy	18.8	11.8	18.6	30.8
Other phys sciences	10.2	8.8	12.2	30.0
Social sciences	7.0	6.1	9.4	12.7
Economics	13.7	11.2	26.3	26.4
Political science	7.0	6.2	10.3	15.7
Psychology	5.4	5.1	5.8	7.2
Sociology/Anthropology	4.9	3.9	12.1	13.1
Other social sciences	7.7	6.3	10.7	20.3

SOURCE: National Science Foundation, Division of Science Resources Studies (NSF/SRS), SESTAT Data file, 1997.

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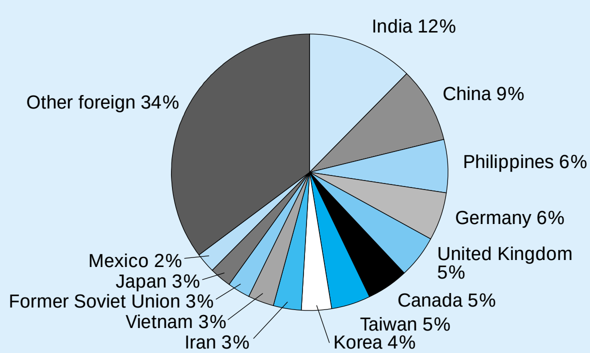
States in 1990.[28] The lowest percentage of foreign-born doctorates was in psychology (7.2 percent) and the highest was in civil engineering (52.0 percent). Almost one-fifth (19.2 percent) of those with master's degree in S&E were foreign born. Even at the bachelor's degree level, 9.7 percent of those with S&E degrees were foreign born—with the greatest proportion in chemistry (15.9 percent), computer sciences (15.6 percent), and across all engineering fields (14.9 percent).

Immigrant scientists come from a wide variety of countries. Countries contributing more than 30,000 natives to the 1.5 million S&E degree holders in the United States are shown in figure 3-15. Although no one source country dominates, 12 percent originated from India, 9 percent from China, 6 percent from the Philippines, and 6 percent from Germany (including those born in the former East Germany). By region, 57 percent originated in Asia (including the Western Asia sections of the Middle East), 24 percent from Europe, 13 percent from Central and South America, 6 percent from Canada and Oceania, and 4 percent from Africa.

The Immigration and Naturalization Service (INS) counts of permanent visas issued to immigrants in S&E occupations

Figure 3-15.
Place of birth for foreign-born S&E degree holders: 1997



See appendix table 3-23. *Science & Engineering Indicators – 2000*

[28] Since NSF's demographic data collection system is unable to refresh its sample of those with S&E degrees from foreign institutions (as opposed to foreign born individuals with a new U.S. degree, who are sampled) more than once a decade, counts of foreign born scientists and engineers are likely to be underestimates. Foreign degreed scientist and engineers are included in the 1997 estimate only to the extent they were in the United States in April 1990. In 1993, 34.1 percent of foreign-born doctorates in S&E and 49.1 percent foreign-born bachelor's in S&E had their degrees from foreign schools.

are shown in figure 3-16. The most recent data for 1998 show a continuing decrease in permanent visas for each S&E occupation from their peaks in 1992 and 1993, after a statutory increase in the number of work-related permanent visas. The total number of immigrants with S&E occupations is now less than in 1991 before the law took effect. (See the sidebar, "Foreign Scientists and Engineers on Temporary Work Visas.")

Permanent visa numbers in recent years have been greatly affected by both immigration legislation and administrative changes at the INS. The 1990 Immigration Act led to increases in the number of employment-based visas available, starting in 1992. The 1992 Chinese Student Protection Act made it possible for Chinese nationals in the United States on student or other temporary visas to acquire permanent resident visas.

Foreign Scientists and Engineers on Temporary Work Visas

One area of policy discussion in recent years has been the use of various forms of temporary work visas by foreign-born scientists. Many newspaper and magazine stories centered on legislation which temporarily increased the 65,000 annual quota for the H-1b visa program through which individuals can get a visa to work in an occupation requiring at least a bachelor's degree for up to six years. Although this is often thought of as a visa for information technology workers, it is used to hire a wide range of skilled workers. Even when a company does not at all consider a worker to be a temporary hire, an H-1b visa can be the only way to put a worker on the job while waiting for a permanent visa. Occupational information on H-1b admissions has not been released, but data are available on the occupations for which companies have been given permission to hire H-1b visa holders (text table 3-23).* Because applications are filed by companies for positions, rather than for a particular individual, many times more applications are filed than either visas issued or applied for. Almost half (47.5 percent) of H-1b certifications were for computer-related or electrical engineering positions. Another 29.2 percent were in medical occupations, primarily as various types of therapists and technicians, but also some medical researchers. Other S&E fields were 9.0 percent, education (including professors) was 3.6 percent, and all other occupations only 10.6 percent of total 1996 H-1b certifications.

*The annual quota on the number of H-1b visas is controlled through the issuance of visas to workers, rather than the applications from companies. Anecdotally, some firms that expect to hire multiple workers on H-1b visas seek permission for many positions, which will also affect the distribution of occupations in text table 3-23.

Scientists and engineers may also receive temporary work visas through intracompany transfer visas (L-1 visas), high-skill worker visas under the North American Free Trade Agreement (TN-1 visas—currently a program primarily for Canadians, but with full access for Mexican professionals coming into place in 2004), and work visas for individuals with an outstanding ability (O-1 visas), as well as several smaller programs.In addition, there is little doubt that much research is done by students (F-1 and J-1 visas); and by postdocs and visiting scientists (J-1 visas, but often H-1b or other categories). Counts of visas issued for each of these categories are shown in text table 3-24.

Text table 3-23.
FY 1997 certifications to hire workers with H-1b temporary visas

Occupation	Certifications	Percent
Computer-related and electrical engineering	189,400	47.5
Medical	116,502	29.2
Other sciences	13,959	3.5
Other engineering and architecture	22,077	5.5
Education	14,249	3.6
Other	42,137	10.6
Total	398,324	100.0

NOTE: The actual occupational distribution of H-1b visa holders might be quite different. Certification is a permission given to a firm to try to recruit a worker who then can apply for an H-1b visa. In FY 1997, only 65,000 H-1b visas could legally be issues.

SOURCE: NSF/SRS Tabulation of Department of Labor administrative data summaries.

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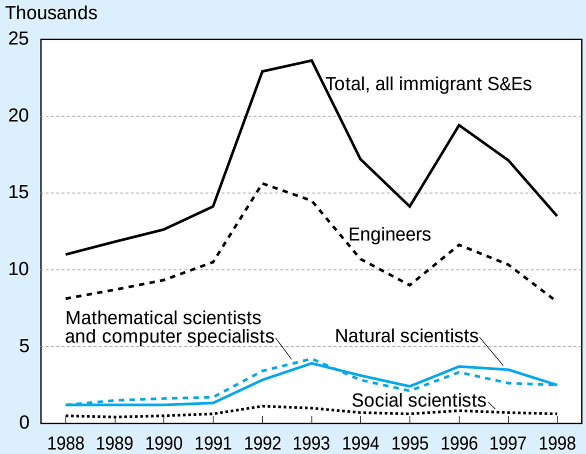
Text table 3-24.
FY 1996 temporary visas issued in major categories likely to include some scientists and engineers

Temporary work visa categories	Issued
H-1b (specialty occupations requiring the equivalent of a bachelor's degree)	58,327
L-1 (intracompany transfers)	32,098
TN (NAFTA visa for professionals)	29,252
O-1 (persons of extraordinary ability)	2,765
O-2 (workers assisting O-1)	1,594
Temporary student/exchange visa categories	**Issued**
F-1 (students)	241,003
J-1 (exchange visitors)	171,164

SOURCE: Immigration and Naturalization Service administrative records.

Science & Engineering Indicators – 2000

Figure 3-16.
Immigration and Naturalization Service counts of permanent visas with S&E occupations



See appendix table 3-24. *Science & Engineering Indicators – 2000*

These changes resulted in at least a temporary increase in the number of scientists able to obtain permanent visas.[29]

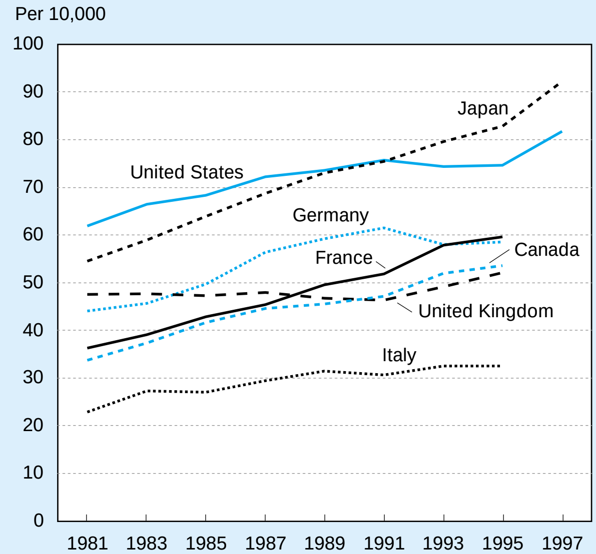
Stay Rates of Temporary Visa Ph.D. Recipients from U.S. Schools

How many of the foreign students who receive S&E Ph.D. holders from U.S. graduate schools stay in the United States? According to a report by Finn (1999), 48 percent of 1992–93 U.S. S&E doctorate recipients with temporary visas were still in the United States in 1994. By field, this percentage ranged from 29 percent in the social sciences to 55 percent in physical sciences and mathematics. (See text table 3-25.) Within each discipline, the percentage of the Ph.D. graduation cohort found in the United States increases with years since degree, reaching 53 percent in 1997. The increase in the stay rate occurs despite considerable evidence from other sources that large numbers of foreign Ph.D. recipients with U.S. degrees leave the United States after completing a postdoc, or at later points in their careers. This suggests a very dynamic picture of the international migration of Ph.D. scientists—with some graduates of U.S. schools returning to the United States even as others leave.

International R&D Employment

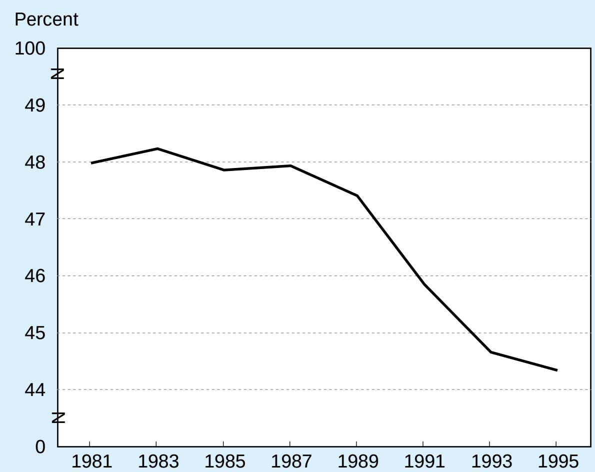
Information on the numbers of scientists and engineers engaged in R&D are contained in figure 3-17, figure 3-18, and appendix table 3-25 for the G-7 nations: the United States, Canada, France, Germany, Italy, Japan, and the United Kingdom. Since 1991, Japan has surpassed the United States in scientists and engineers engaged in R&D as a percentage of their labor force, but the United States continues to have a greater proportion of R&D workers than the other included industrial countries. In terms of total numbers of R&D scientists and engineers, the U.S. share of the G-7 total of scientists and engineers engaged in R&D, as reflected in figure 3-18, has fallen slightly from 48.0 percent in 1981 to 44.3 percent in 1995.

Figure 3-17.
S&E labor force engaged in R&D per 10,000 labor force



See appendix table 3-25. *Science & Engineering Indicators – 2000*

Figure 3-18.
U.S. scientists and engineers engaged in R&D as a percentage of the G-7 total



See appendix table 3-25. *Science & Engineering Indicators – 2000*

[29] In addition, the easier availability of occupation-based permanent visas affect the measurements—many scientists enter on family-based visas, where reporting of occupation is optional. If more of these individuals were using occupational visas, we would identify more immigrants in S&E occupations for that reason.

Text table 3–25.
Recipients of 1992-93 doctorates with temporary visas at time of degree who were in the United States, 1994-97

Field	Temporary resident doctorate recipients	1994	1995	1996	1997
Physical sciences and mathematics	4,821	55	59	60	61
Life sciences	3,765	48	51	53	54
Social sciences	2,278	29	31	32	32
Engineering	5,527	49	53	53	54
Total, S&E fields	16,391	48	51	52	53

SOURCE: Finn ,1999. *Stay Rates of Foreign Doctorate Recipients from U.S. Universities.* Oak Ridge, TN: Oak Ridge Institute for Science and Engineering

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